Copy-Cat Tape Decks

These new cassette decks feature two tape transports that let you copy tapes with ease and dub like a professional.

BY ARTHUR J. ZUCKERMAN

The dual-transport tape deck, considered a novelty when it came out about two years ago, is capturing the fancy of music lovers. It gives you the ability to copy, or dub, a cassette without borrowing another deck and hooking it up to yours. One-machine copying is great if you've got a cassette player in your car, or use a cassette portable.

Dual-transport decks list for as little as $200, and the top price for a model loaded with special features is only about $450. Currently, they all have one major characteristic in common: One transport both records and plays tapes, and one only plays them. So, you can copy from one tape to the other, but you can't record on both simultaneously from an outside source.

A less universal but widely shared feature is high-speed dubbing. It permits decks to make copies in half the normal playing time or less, in addition to dubbing tapes at the standard cassette speed of 1⅞ inches per second (ips). Another common feature is continuous play. One cassette (usually the one in the play/record transport) starts playing when the other one stops.

We put six dual-cassette decks and one portable through their paces. The

The arrow from the Realistic SCT-28 symbolizes the most popular use of all these dual-transport tape decks: One unit allows you to copy tapes as well as dub from one tape to another. The SCT-28 even copies tapes at high speed. The unit also has a continuous-play function. When the tape in the first bay finishes playing, the tape in the second bay starts automatically. Above the SCT-28 is Aiwa's entry, Model WX110. This deck not only copies at high speed, it can copy both sides of a cassette simultaneously, which means an entire C-90 cassette can be dubbed in 22½ minutes. The Aiwa unit also features extras, such as Dolby C.

decks were the Sanyo RD W50 ($199.50), the Realistic SCT-28 ($339.95), the Sansui D-99D ($350), the Onkyo TA-W88 ($380), the Aiwa WX110 ($395) and the Cybernet DD701 ($425); the portable was Sharp's RD-688AV ($650).

Sanyo RD W50

The modestly priced Sanyo is a no-nonsense, basic machine. It operates at only the standard speed, and it has no microphone inputs. Equalization and recording bias for normal (ferric oxide), chrome (chromium dioxide) or metal (metal-particle) tapes are set manually, as is the recording level for a line source such as an amplifier, receiver or recorder. But the recording level for tape dubbing is set automatically. Setting the deck for dubbing also automatically turns off its Dolby B noise-reduction system.

To copy a cassette, you load transport 1 with the tape to be dubbed and transport 2 with a blank tape, and you set the input-selector button to the "tape 1 to tape 2" position. Then you engage the pause controls for both tapes and set transport 1 in "play" mode and transport 2 in "record" mode. Release the two pause controls simultaneously, and you're in business.

This no-frills Sanyo model does have a simple program-search system for transport 1. If you push in its rewind key while it's playing, the tape will wind back to the dead interval (which must last at least four seconds) between the beginning of the selection you were playing and the end of the one before it. It will then start playing the selection over again. Pushing the fast-forward key during "play" mode makes the tape advance to the null at the beginning of the next selection. Holding in the rewind or fast-forward key when the tape reaches a null will make the tape continue to the next selection.

Realistic SCT-28

The Realistic deck copies tapes at either standard or high speed, and has more features. Equalization for the tape 1 (play-only) transport is set automatically, but equalization/bias settings for the tape 2 (record/play) transport are made manually. There is a manual fine-adjust knob for setting the recording bias to match precisely the different kinds of normal tape.

Jacks for left- and right-channel microphones are provided. A single mike, if plugged into the left-channel jack, is fed to both channels. But a mike *can't* be mixed with any other source. Dubbing procedure is like the Sanyo's, except for the high-speed option. Tape search on the Realistic is also similar to Sanyo's.

This deck also has a continuous-play function that is actuated by pushing in the "play" buttons of both transports after the "continuous play" switch is set. Tape 1 starts, and when it ends, tape 2 starts automatically.

Sansui D-99D

Sansui's dual-cassette offering provides only standard speed for dubbing.

(Please turn to page 170)

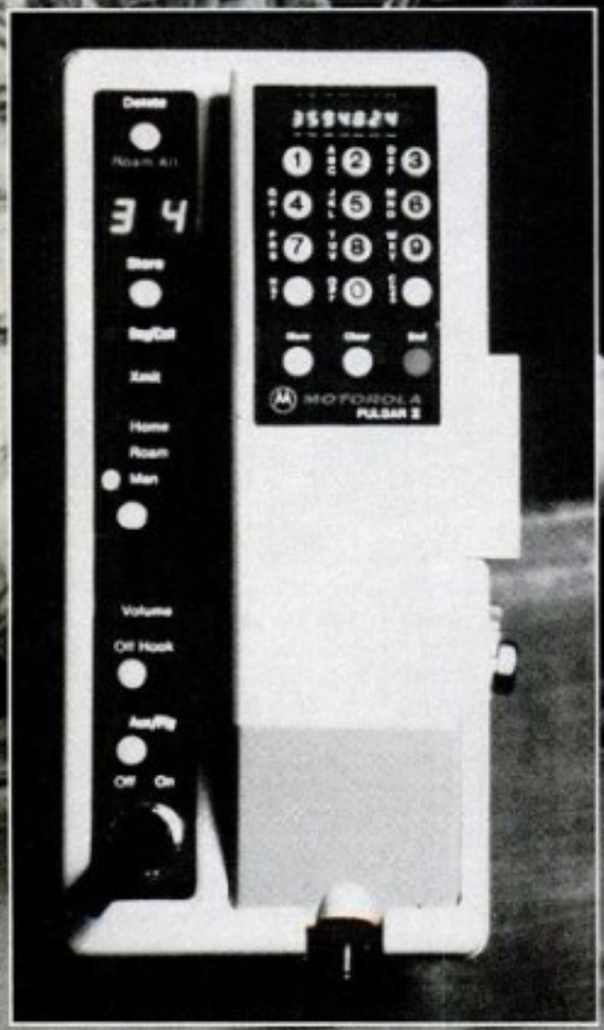
Sansui's D-99D is one of the most automated units we sampled. It has two program-search systems. The tape transport on the left will search backward to the beginning of a song and play it again. The transport on the right is a more sophisticated searcher and will allow you to skip ahead up to nine selections. The RD W50 from Sanyo is a basic two-mouth tape deck. Many of its features, such as dubbing, tape copying and record-level metering, are now considered standard among these decks. The RD W50 is a good buy for beginners.

SANSUI D-99D

PM photo: Bill Ashe

Traveling telephones

–new technology expands mobile/portable service



Mobile-telephone control head (handset and base) is connected to microcomputer-controlled transceiver in trunk. Motorola's Pulsar II phones, now in use, will be modified for new 900-MHz-band cellular telephone systems.

Computerized switching and a technique called frequency reuse get more talk into new mobile bands

By JOHN MASON

There's a button labeled SND on Motorola's futuristic-looking Pulsar II radiotelephone. I pushed it, and a number stored in its microcomputer memory began stepping, digit by digit, across the red LED handset display. This amazing car telephone not only remembers 10 often-used phone numbers, but calls any of them at the press of one button.

Earlier, at Motorola's Communications Group plant outside Chicago, I had picked up a portable Dynatac (Dynamic adaptive total area coverage) phone, tapped out a number on its Touch-Tone keypad, and called my New York office. Electronic gear at the plant patched my call directly into the phone network. A mobile/portable-telephone operator wasn't needed.

Advanced mobile and portable telephones are already in use throughout the country. Motorola markets its $890 Pulsar II (less transceiver) for 150- and 450-MHz systems; its Dynatac portables aren't available yet, although other compact portable phones are sold and leased.

But while fancy hardware for on-the-go telephone calls is readily available, the radio frequencies needed to carry today's heavy volume of mobile/portable calls are not available. Because radio channels are so limited, there are long waiting lists in most cities for mobile-phone service.

One cure for this congestion, according to communications experts I've talked with, is a blend of the latest in computer and RF technology and the concept of radiotelephone cells and frequency reuse. The two phones I used are examples of this new technology.

The concept is simple. A conventional mobile-phone system uses one high-powered central transmitter and a sensitive receiver serving all mobile units in the area. Thus a single frequency can be used by only one mobile unit at a time. In a cellular arrangement, the high-powered central transmitter/receiver is not used. Instead, many smaller transmitter/receivers that each cover only a few square miles are installed. Now, a given frequency can be used simultaneously by mobile units in several different areas or "cells" without interfering with each other. The result: A lot more calls can be placed on a given frequency band, and a lot of those people on the waiting list for portable phones can get service.

While the system is simple in principle, it is enormously complicated in practice. How do you decide which mobile unit gets which frequency at which time? And how do you make sure that two adjacent cells aren't using the same frequency simultaneously—a situation that could possibly cause interference? The answer is a complicated system of computer control. While details vary from system to system and even within systems—more about that later—here's how one typical setup might operate.

In the system now planned by Motorola for the Washington-Baltimore area, the entire region would be broken into five hexagonal cells, each with an 11-mile radius (see diagram).

The base antenna serving some hexagonal cells has six V-shaped sector transmit-and-receive antennas, breaking each of these areas into six smaller cells.

What happens when you're driving around and somebody calls your number? "The system first has to locate a mobile unit in order to assign a proper channel in the proper cell," says Motorola group product manager Andrew Daskalakis.

Pinpointing and monitoring your location is accomplished with computers—nine will ultimately be used in the Washington-Baltimore developmental system.

Computer in your trunk

For an incoming call, computer data on special signaling channels are beamed over all cell transmitters. A powerful microcomputer built into the bread-box-size transceiver in your car trunk recognizes your mobile code. Your computer then transmits a signal that instantly tells a base-station computer what cell you're in.

Next, to determine how far you are from the cell antenna, the main computer sends a six-kHz tone to your mobile. This tone triggers a transponder that retransmits the tone back to the base-station receiver. By comparing phase differences between the transmitted and received tone, the distance from the base to your car is computed.

Using this distance information, and the strength of your computer's signal, the base computer can crank the power output of your mobile transmitter up or down. "It takes care of the portable-in-the-high-building problem, and the mobile-on-a-high-hill problem," says Daskalakis. Traveling telephones at those elevations can transmit much farther than normal, interfering with other cells.

Portable telephone developed by Motorola for 900-MHz cellular systems synthesizes 666 channels, has a one-watt transmitter and flat antenna.

The inaudible chitchat between computers—redundantly coded to prevent errors from static or fading—takes only a split second. Your mobile is automatically tuned to a voice channel. Once you're "linked up," the main computer actuates the "ringer" in your mobile.

After you answer your call, and while you're driving, the main computer periodically scans your mobile to monitor your location. If you move to where another cell transceiver would provide better reception, the base computer switches you instantly. A similar "handshake" between computers occurs just before the dial tone when you place a call.

The system just described would go into operation in stages. In less heavily populated areas (see map), a less complicated system would be adequate. There, the receiver section of the base station would use multiple antennas to split the cell into six pie-shaped sectors. These high-gain receive antennas can pick up signals from low-power (one

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watt) portable telephones. But a single omnidirectional transmit antenna could cover the whole cell.

Another cellular system is now beginning experimental operation in Chicago. It is operated by Illinois Bell, and, while the principles are the same, it differs somewhat in operating details from the Motorola system. The Chicago system, for example, will initially have 10 cells, each with an eight-mile radius from its central transmitter. Cell coverage will blanket a 2100-square-mile region in Chicago.

This eight-mile-cell system, however, is less sophisticated than the setup originally proposed by American Telephone & Telegraph Co. That system, presented in 1971 to the FCC, specified four-mile-radius cells, with directional antennas at alternate corners of each hexagonal cell (see diagram). With four-mile cells, frequency reuse would be possible in cells 18 miles apart.

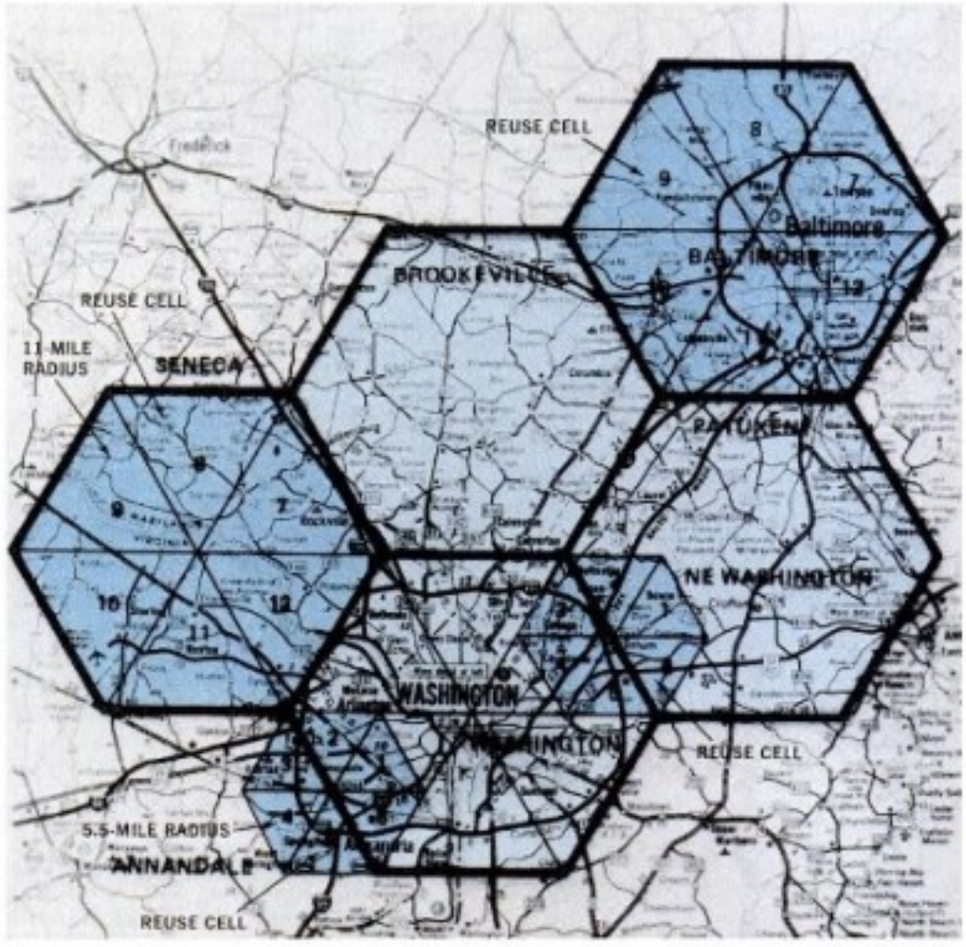
In the system being built, frequency reuse is only possible in two cells, about 48 miles apart. Conventional mobile systems usually have a reuse distance greater than 100 miles.

"We're authorized to serve 2500 customers," says James Troe of Bell Laboratories' telephone-service trial department, which is setting up the new system. "We're sizing the system and channel capacity to accommodate that level," he said, to explain why AT&T is building a less-costly system.

Smaller cells would come later to meet growing demand. Companies can expand cellular systems to serve tens or hundreds of thousands —simply by adding more transmitters, shrinking cell sizes, and reusing the frequencies more often.

While the Illinois Bell system is basically compatible with the Washington-Baltimore setup, there are some differences. A Motorola Dynatac portable, for example, would not function adequately in the initial Chicago system, which lacks sectorized high-gain receive antennas, although a Dynatac car telephone would.

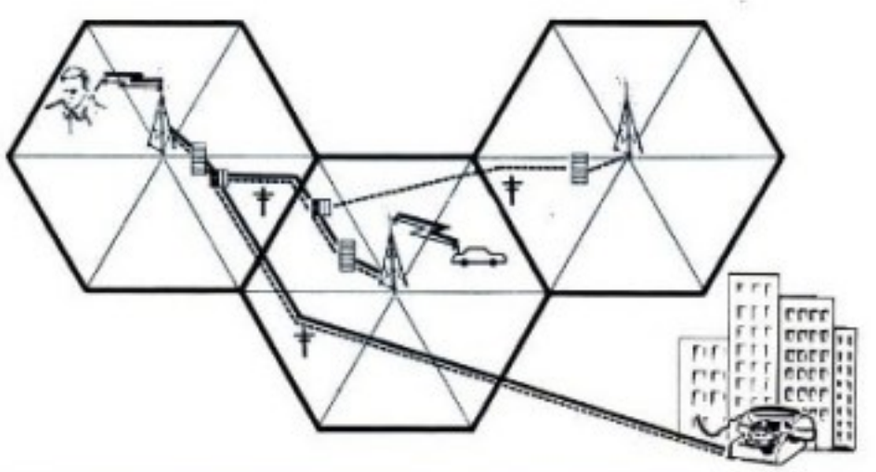
The drive to develop systems that use scarce radio-spectrum space efficiently goes back to 1968, when the FCC began considering what to do about the tremendous demand for mobile-telephone service and the lack of frequency space to satisfy that demand. At that time, mobile phones operated in the 35-, 150-, 450-MHz bands.

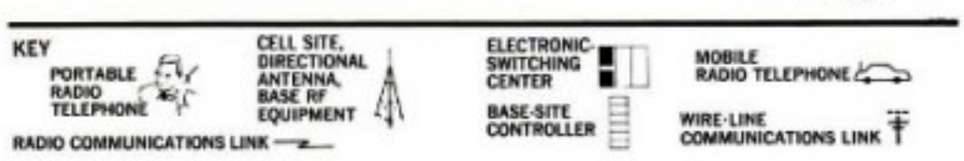


Eleven-mile-radius cells planned for Washington-Baltimore permit simultaneous use of same frequencies in different cells, so more subscribers can use system at one time. Low-user cells such as Brookeville may have one central omnidirectional antenna. In high-use regions, central antennas create six 60-degree-wide cells in large cell; smaller 5.5-mile cells boost frequency reuse further.

How computers route calls for mobiles and portables

Switching centers and transmitters/receivers at each cell site will distribute Motorola's Dynatac computer system throughout the Washington-Baltimore system. Local equipment failures won't disrupt the entire mobile/portable network. Directional antennas and measuring equipment at each cell pinpoint the location of a portable or mobile phone making a call or being called. Computers at the cell sites and within radiotelephones automatically tune transmitters and receivers to the proper channel. Switching centers at cell sites use minicomputers and microprocessors to connect radiotelephones into the wire-line network. Audio in each switching center is digitized to permit electronic switching without conventional crossbar switches or reed relays.





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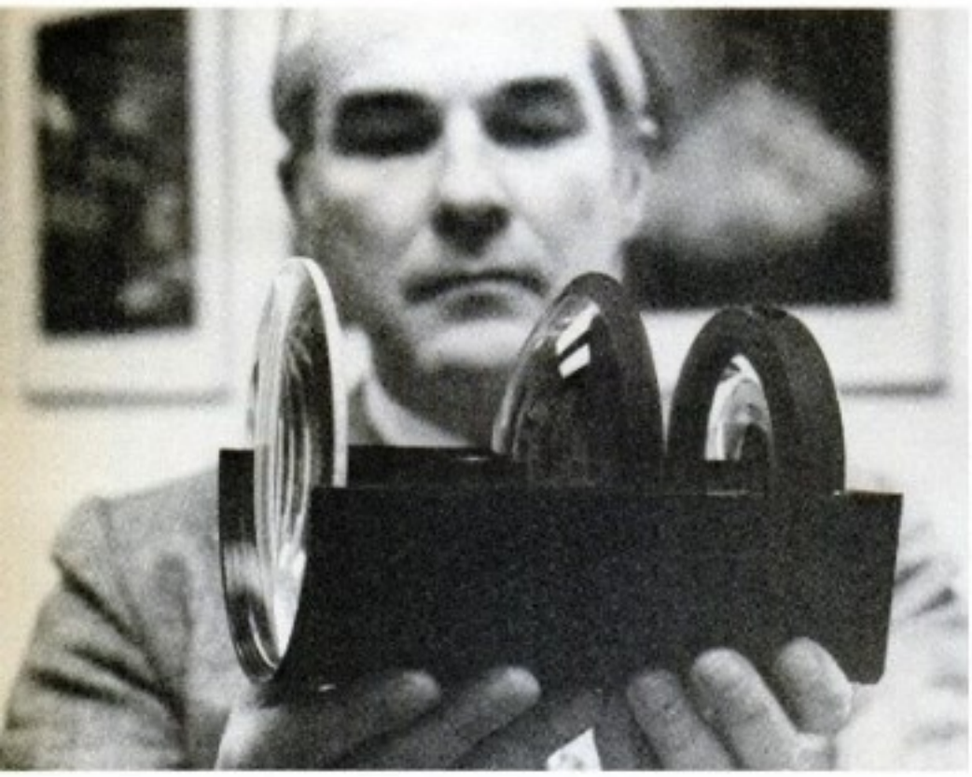
Three new ways to low-cost, super-bright **giant-screen TV**



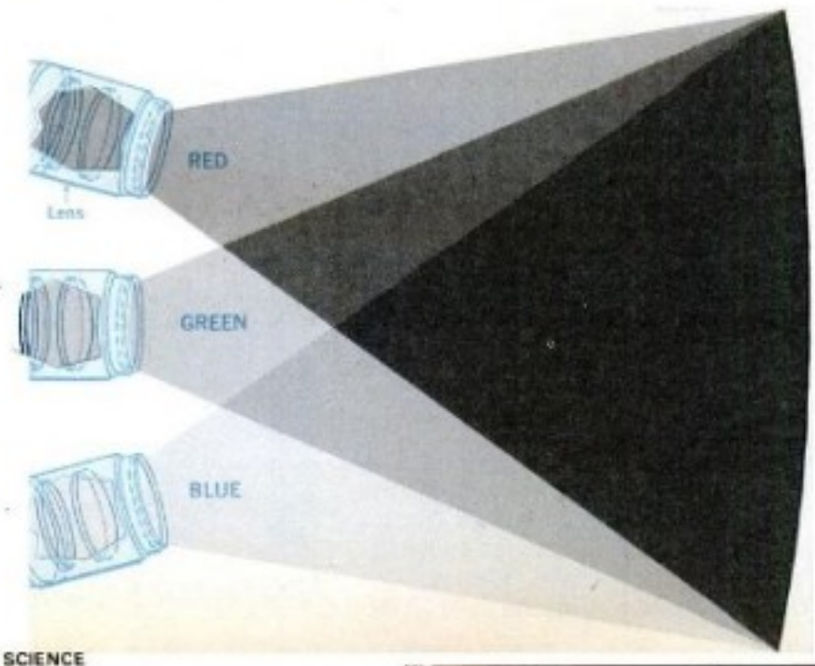
Next-generation projection sets promise brighter pictures at lower cost

By C. P. GILMORE

I have just returned from a trip to a small laboratory/factory in the shadow of MIT in Cambridge, Mass.; to a plant just outside Cape Kennedy, Fla.; to a plastic-lens factory in the rolling hills east of Cincinnati. In these diverse facilities, a new generation of projection television is being readied for production. Some of these units will be on the market before the end of this year. I am convinced that they will launch a new age of giant-screen projection TV for the home.

Of course, projection TV has been around for some time. Advent put a high-quality set on the market back in 1972 [PS, Sept. '72]. Other three-tube sets using both Schmidt and refractive optics (see diagrams) have come on the market since then and are now available in the $3000-$5000 range. Also available are a number of "one-eyed monsters"—small television sets in a box with a projection lens in front of the screen. They project a considerably dimmer image (though some are okay in subdued light), and most fall in the $1000-$2000 range.

Two of the three new approaches I've just seen are similar to current three-tube sets: One is a Schmidt; the



Refractive system uses three high-brightness tubes plus three fast lenses to project red, blue, and green images that combine on screen to form color picture. Roger Howe holds revolutionary f/1.0 plastic aspheric lens that makes possible refractive system rivaling more sophisticated Schmidt system in brightness.

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other, refractive. But they feature advances that make them dramatically cheaper and at the same time brighter and sharper. The third is totally new. All three produce high-quality, superbright projection TV at a price substantially below anything remotely comparable in quality today.

The Novatron

Henry Kloss started Advent Corporation 12 years ago to make a projection-television set with a mirror inside the tube—a Schmidt projection system. "It was quite an effort to get this system, with parts that had to be kept to tolerances of within a couple of thousandths of an inch, in the tube and stabilized," he told me recently. "So I chose a heavy-handed way that I knew would work." The inner structure was composed of more than 20 steel parts, which had to be carefully assembled and aligned before being sealed in the glass envelope.

Two years ago, Kloss left Advent and retired to his basement for a year. "I had the luxury of having the time to see if I could find a more elegant way to make the tube," he continued. "If you want to reduce things to a minimum, you've got to have a mirror. You need a vacuum enclosure. You need a window for the light to get out, and a place to put the phosphor. Now suppose you make the mirror as part of the tube (which had been suggested, but I don't think ever done commercially before), and let the faceplate carry the phosphor. The mirror and phosphor for optical reasons must have the same center of curvature. If you separate these two spherical surfaces by an accurately ground cylinder—the barrel—it's got to come out right. The accuracy of the position of the barrel isn't important. If it has

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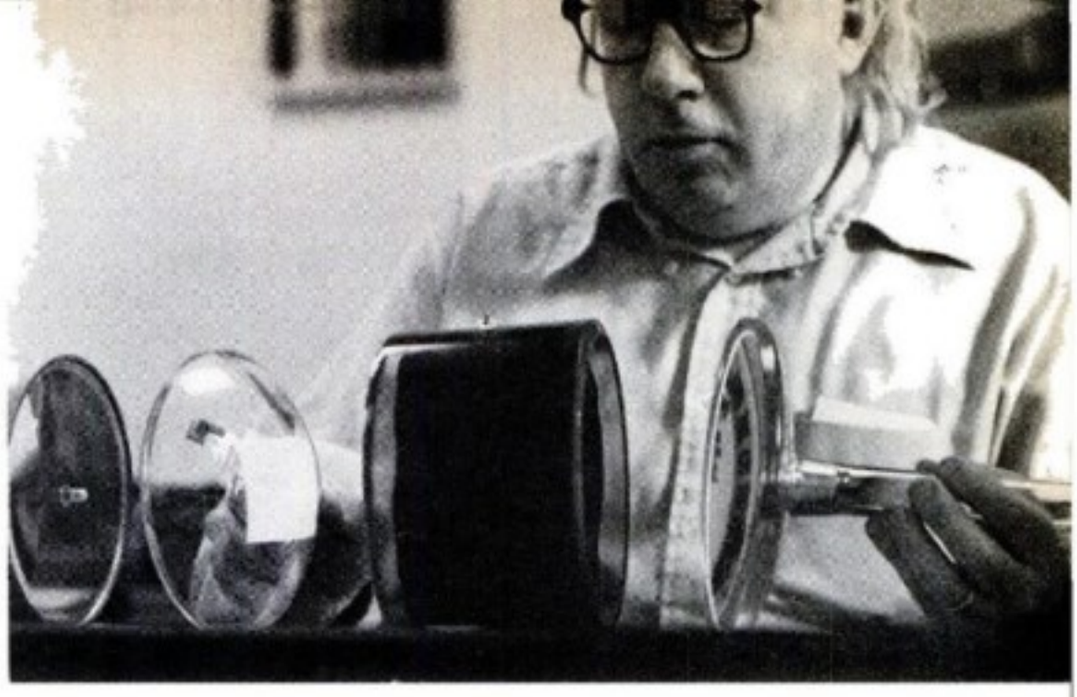
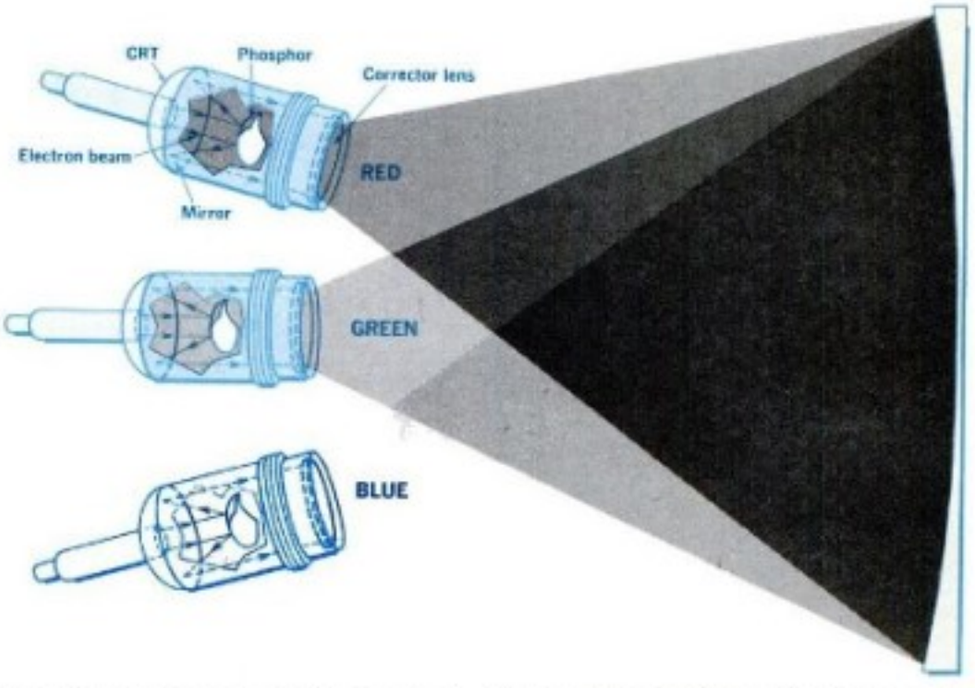
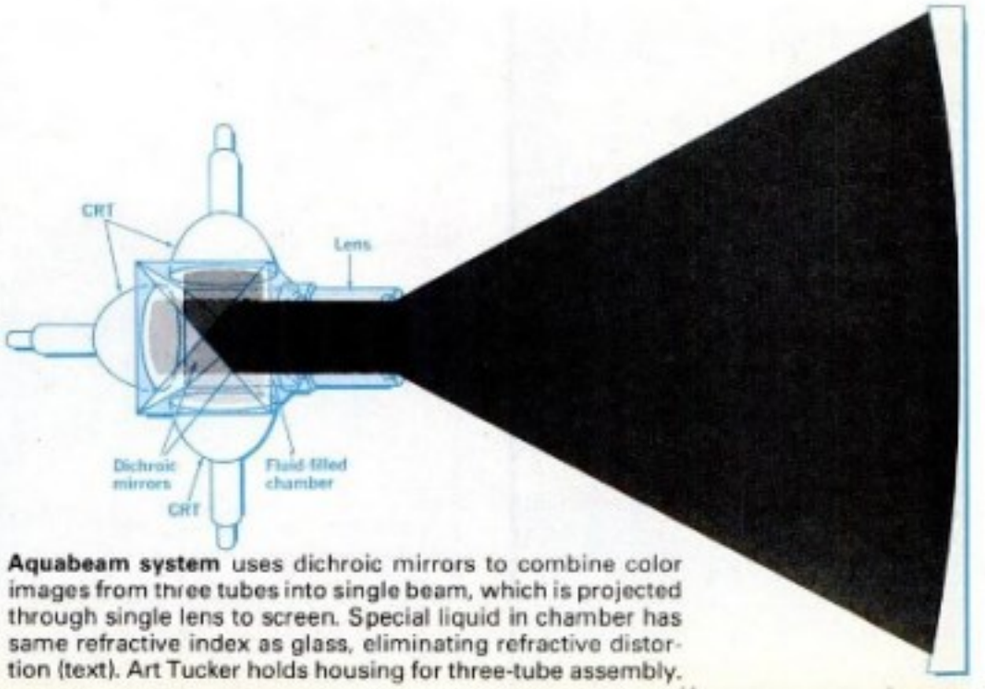




Schmidt system uses electron beam to form image in each tube, telescope optics to project enlarged color pictures on screen. New, elegantly simple construction developed by Henry Kloss cuts costs and reduces parts to minimum: neck with integral mirror, barrel, faceplate with phosphor target, and corrector plate.



Aquabeam system uses dichroic mirrors to combine color images from three tubes into single beam, which is projected through single lens to screen. Special liquid in chamber has same refractive index as glass, eliminating refractive distortion (text). Art Tucker holds housing for three-tube assembly.

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spherical curves ground into its end, then the two end pieces will automatically be held in perfect alignment."

Kloss showed me what he meant. He set up a tube neck with mirror, a cylinder, and an end plate containing phosphor. Then on an optical bench he shot a beam of laser light through the axis of the system. As he moved the barrel around, the laser beam showed that the two optical elements remained in perfect registration.

Once the basic concept was hatched, there remained the problem of seeing if it could be built. "Here is a little research furnace that came from my basement," he said, walking through a laboratory at his new Cambridge firm, Kloss Video. It was a 20-gallon stainless-steel lobster pot enclosing a smaller pot and fitted with an elaborate array of Calrod electric heating elements. "The key was to be able to differentially heat the mirror, different parts of the cylinder, and the faceplate to appropriate temperatures. I had four Variacs for controlling heater temperatures, and night after night I sat down there trying different temperature schedules so that when the glass came out it was free of strain."

The new Novatron tube has many advantages. Because of its simplicity and ease of manufacture, it's cheaper than other Schmidt-type tubes. It's also brighter. "The electron beam has a better focusing system on it, so you can put higher beam current in," says Kloss. "And the phosphor can be kept cooler because we can get to the back of that glass and put a heat sink on it."

When I went into a lab, all fluorescent lights were on. But the picture at the far end of the room was bright and sharp. "You can measure 120 foot-lamberts in highlights on that picture," said Kloss. "We may run it slightly below that—say, in the 100 foot-lambert range. At that level, we've learned, we can get many thousands of hours of life out of the tubes; we don't know where the actual end of life is." Kloss is setting initial production plans at 100 a month, and plans to show his first commercial set with Novatron at the Consumer Electronics Show in Chicago in June.

The refractive-optics system

This approach is now being championed by Roger Howe, chairman of the board of U.S. Precision Lens, which makes the revolutionary lenses that really put refraction systems in the super-bright category. But oddly, this approach, too, was launched by Henry Kloss. The principle is simple. Put a lens in front of any light source and you project a picture. Many of the projection-TV sets on the market now—the one-eyed monsters—use a lens and a regular TV set to project a bright enough image to see in a darkened room.

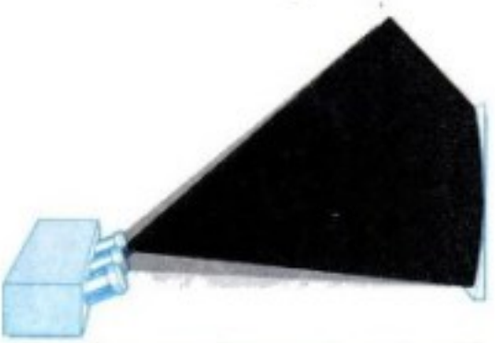
Can that simple system be improved? Henry Kloss began to wonder about that in the mid-1970's, after the Advent Schmidt-optics system was on the market. "Electrohome in Canada had some higher quality circuitry than other places and was interested in projection TV," he recalls. "Roger Howe at U.S. Precision Lens was willing to try to make faster, cheaper lenses. There is an oversupply of tube-making equipment. These elements began to come together in my mind."

Kloss decided to make a system using three regular monochromatic tubes—one blue, one green, and one red—then combine them optically to make the full-color image. With three tubes eaeh giving off light, the total light output could be high. If a fast lens (one that transmits a lot of light) could be found, that would make it brighter still. So Kloss asked Clinton Electronics Co. to develop a brighter, more accurate version of its monochromatic tube; Electrohome to work on circuitry; and Roger Howe to build a fast lens.

The lens U.S. Precision developed was an f/1.4, injection-molded of acrylic. Kloss used it to make the Advent 750, which has since been repackaged to become the 760. It was a successful product, and the first three-tube refractive home set on the market. Although not quite as bright as the Schmidt optics set, it was still bright enough for comfortable viewing.

The technical trick that made this possible was the development by U.S. Precision of a way to make large, thick plastic aspheric lenses with optically acceptable surfaces.

This development not only made lenses cheaper, but it had an additional advantage. It freed lens designers from the constraint of having to use lenses with spherical surfaces, as they must do with glass. By calling for aspheric lenses with complex shapes, designers could make extemely fast, simple lenses with fewer elements. And since the U.S. Precision process is so much simpler than grinding glass lenses, the lenses could be far cheaper than those made of glass by the traditional method. Once U.S. Precision had made the f/1.4 lens for Kloss, the company decided to see if it



Two-piece units house projector in cabinet that sits in middle of room. Projector-to-screen distance is critical; must be held to within about an inch of design distance. Units are Advent 750 (left), Advent 760 (top), and Mitsubishi 700U.

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could push the technology still further. So it developed an f/1.0 lens, which has twice the light output.

Suddenly new possibilities loomed. A refractive set could be made with the new lens that could be twice as bright as before. "So now it's a real horse race between our technology and the Schmidt technology," says Howe.

The lenses sharply reduce the cost of projection television. Much slower glass lenses, such as are now used in the Japanese sets, cost as much as $200 each in quantity. But Howe says that any manufacturer who buys his new f/1.0 lenses at the rate of a thousand a month (a small number for a mass-market product) can get them for $155 for a set of three—enough to make a television set.

Howe led me into a viewing room with a projection set using the new f/1.0 lens. It produced a beautiful, bright, sharp, clear picture in a well-lighted room.

Howe's lenses could be an important factor in projection TV. They're now available off-the-shelf. So are super-bright monochromatic tubes from Clinton and other manufacturers. TV electronics can be bought as a package. So anyone who wants to can now put together an ultra-bright, relatively low-cost television set by simply buying all of the parts and putting them into a case.

One-piece units house projector in base, use outrigger mirror to reflect image on screen. Mirror folds, closing set when not in use. Units are Sony KP-7200 (bottom) and Panasonic CT 6000. Quasar markets a unit similar to the Panasonic.

The Aquabeam system

Back in the early days of projection television, many of the sets seen in theaters, hospitals, military installations, and other commercial and industrial applications were built by an electro-optical expert named Art Tucker. Although Tucker had built many Schmidt-type systems (including a $28,500 system that produced a 40-foot picture for use in theaters in the late 1950's), he was concerned with several problems inherent in the design. For one thing, a Schmidt system must be engineered for a fixed picture size and a fixed projector-to-screen distance. And getting the three beams from the three color tubes to converge is complicated.

Tucker had also built and sold several thousand refractive optics systems using glass lenses back in the '60's. They cost $6800 and were sold mostly to schools. But he decided a couple of years ago that this was not the ideal approach either and that a new kind of system was needed.

So he set about to try to develop a system that would combine the three beams of light before the lens, so they could be projected as a single beam through a single tube. This would allow a single system to produce an image of any size. Just move it toward or away from the screen, focus like a slide projector, and the image size changes. But to work properly, a lens must be close to the face of the cathode-ray tube whose picture it is projecting. "So how do I get the tubes to think they're close to the lens and still stuff the mirrors in between?" asked Tucker.

He did it in an ingenious way. Tucker made a plastic box with windows on all four sides (see diagram). Inside, he mounted two dichroic mirrors. A dichroic mirror reflects light of one color or wavelength while passing most of the light of different wavelengths. When the mirrors were arranged properly, the result was a head that combined the images from the three tubes into a single beam, which could be projected by a single lens.

But there was still one problem. When a light beam goes from glass to air or vice versa, it is bent sharply by a phenomenon known as refraction. Since various images were traveling through varying numbers of glass-air surfaces, refraction seriously distorted some of the images.

So Tucker devised another solution. He filled the box with a liquid with very special properties. It has precisely the same refractive index as the glass used on the face plates, for the internal mirrors, and at the exit pupil. Thus the glass effectively disappeared, there was no refraction of light internally, and refractive distortion was eliminated.

Tucker has just set up his new company, The Big Picture, Inc., in Titusville, Fla. When I was there, he was setting up production facilities: heavy injection-molding equipment for the optical elements and housing of the projection head, electronics assembly areas, and so on. Initial plans call for him to manufacture 2000 sets that will sell for about $5000 and be placed in institutional settings—bars, hospitals, auditoriums. Tucker figures that once he gets that many out in the field, he'll get enough practical experience to impress major TV manufacturers who might want to license his equipment. Ultimately, he hopes to manufacture only the projection head, selling it to the big home-TV makers for inclusion in their sets.

His units are impressive. He showed me sets that produce pictures considerably brighter than those from either the Kloss Schmidt system or the Howe refractive system. The liq-

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Hand-held computers

At home, in the office, on the road—these small computers give you brainpower to go

By V. ELAINE SMAY

One evening last week as I closed my file folder labeled "Hand-Held Computers," I thought it felt a bit lumpy. Sure enough, tucked inside, unseen among the papers, was one of the little buggers, the Sinclair ZX80.

The ZX80 is one of a whole new generation of personal computers that, if not quite pocketable, are at least small enough to be carried in an attaché case. Panasonic, Quasar, Commodore, Newbury Laboratories, and Sharp are to begin selling very small computers in the U.S. sometime this winter. Radio Shack and Sinclair already are.

These machines are true computers. They can be programmed in BASIC, the pidgin English people use to communicate with many computers. And you will be able to buy prepared programs (software) for them to do such jobs as keeping track of your personal finances or teaching your kids arithmetic. All will be relatively inexpensive—from $200 to $500.

And all will be portable, but not to the same degree. The Sinclair, the Commodore, and one of the three models from Newbury Labs depend on AC power and have no built-in display; they must be hooked up to a television set or video monitor. So while they're small and light enough to tote from home to office, they can only be used where line power and a television screen are available. The others, however, have a one-line integral display and can run on battery power.

These hand-held computers differ considerably in just what they can do and in what accessories (peripherals) can be used with them to make them do more. For example, if you want to transfer the information on the display to paper, you need a computer that can drive a printer. If you want access to consumer data banks, such as The Source or MicroNET (see "Info Banks Make Your Home Computer Smarter," this issue), you'll need a modem (modulator/demodulator) so that your computer can talk over telephone lines to another computer. If you want to write programs and store them, you need a computer that can use a tape recorder to transfer data to and from cassette tapes, or one that hooks up to a disk storage system, a high-speed recording device that saves data on floppy disks of magnetic recording material. Some of these peripherals will be available for some of the computers, but not all for all.

Finally, these little computers come with relatively small memory space, which limits the complexity of the programs and data they can handle. If you want to be able to graduate to more sophisticated programs, look for one to which memory can be added.

Following is a closeup look at six of these new computers. The seventh, the Sharp PC-1211, is available in Japan. Our contributor, Michael White, got one there and tells how he uses it in the article that follows.

Radio Shack

The TRS-80 Pocket Computer measures seven by 2¾ by ½ inch, weighs six ounces, and is powered by four mercury cells. Its liquid-crystal display has space for 24 characters. (See "What's New in Electronics," this issue, for a photo of the TRS-80.)

"We've found that a lot of the things you can do with the Model I TRS-80 desk-top computer can also be done with our new pocket model," says David Burdick, director of computer center merchandising at Radio Shack. "Although it has only 1.9K (kilobytes) of random access memory (RAM) compared with 4K for the Model I, it can handle longer programs than you'd think because of the specific BASIC it uses." Its 1.9K memory cannot be expanded.

The Pocket Computer is a versatile calculator, with 15 arithmetic functions, a floating decimal, and accuracy to 10 digits. "It will perform anything the programmable calculators do—as well or better," says Burdick. "And it is a lot friendlier because it prompts you in English."

The TRS-80 Pocket Computer sells for $250; an optional cassette interface is $50. With that, you can save your own programs and use the software (on cassettes) that Radio Shack sells. Eight programs are now available. Another half dozen are in the works, Burdick reports. The company is considering making a printer for the TRS-80, and maybe a modem.

Quasar and Panasonic

The Quasar Hand-Held Computer and the Panasonic RL-H1000 are nearly identical machines, developed by Matsushita, the parent company. They are nine by 3¾ by $1\frac{3}{16}$, have one-line, 23-character liquid-crystal displays, and run on either rechargeable nicad batteries or line current. Both should be on the market by December. Target price: $400–$500.

For that you get a machine that is not really a computer—you can't write or run programs on it. But it can do a number of useful things. It has a clock/calendar function that keeps

Continued

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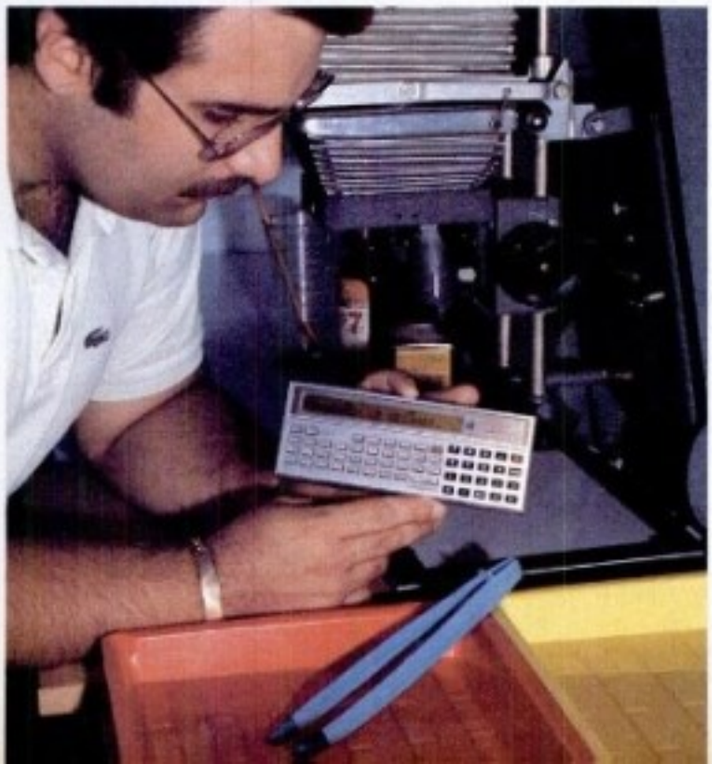

Sinclair ZX80 comes with video cable that connects to UHF terminals on TV; display is black on white. Programs can be saved on tape cassettes and loaded from tape. Cables from MIC and EARPIECE sockets on the cassette recorder connect to ports on the ZX80. Getting the recorder to work with the computer can be tricky, however. The owner's manual offers some hints.

Sharp PC-1211 has one-line display and runs on batteries. Author White (following story) uses it frequently in his darkroom. He has programmed it to time fixing and washing operations simultaneously, and he uses it to scale formulas for precisely mixing developing chemicals. The PC-1211 is not yet available in the U.S., but the Radio Shack TRS-80 Pocket Computer is similar.

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track of the year, month, date, hour, minute, and second. In this mode, it can be an electronic appointment calendar. "You can set alarms," says Phil Callihan, Quasar's product manager, information processing systems, "and you can put in a message. When the alarm goes off you push a button, and the display reads, GO TO LUNCH WITH GEORGE."

The hand-held computer also can act as a memory file to store addresses, phone numbers, formulas, and notes. And it is a four-function calculator.

To do more with it, you have to buy more stuff. For example, it knows how to work as a language translator. But to use that function you must buy a preprogrammed read-only memory (ROM) chip that plugs into the back. Four of these add-on ROM's can be used at a time; an optional interface device lets you add four more.

A plug-in ROM will also teach the computer BASIC so you can program it. But you won't be able to do a lot of programming because the computer contains only 1K of RAM. Initially, the companies will sell a 12K-RAM expander module. The machines are capable of expanding up to 73K, and possibly more.

Highest on the priority list of peripherals are a miniprinter, modem, cassette-recorder interface, the 12K-RAM expander, and an input/output (I/O) interface that lets you use more than one peripheral at a time. "Further down the line we're planning to offer a TV interface, more RAM, and disk storage," says Dennis Reer, Panasonic's senior project engineer for digital products.

Sinclair

The Sinclair ZX80, introduced to PS readers in May (see "Hand-Held $200 Home Computer"), is 6½ by 8½ by 1½ inches and weighs 12 ounces. It has no display (you must connect it to a TV set), and it's powered through an adapter from an AC outlet. It generates a black-on-white display with 24 32-character lines. The keyboard is a flat, touch-sensitive type. It includes 24 standard graphic symbols as well as the usual alphanumeric keys.

The ZX80 has 1K of RAM built in. For more sophisticated programming you can expand the memory to 16K with an optional RAM expansion module (cost: $100). The BASIC the Sinclair comes with does only integer math. "But you can take out that ROM chip and plug in another that will have a more powerful version of BASIC with a floating decimal and all the advanced mathematical functions," says Nigel Searl, Sinclair's marketing director. Cost: about $40.

The ZX80 has a built-in cassette-recorder interface. By January, Sinclair expects to have a low-cost printer available. Other peripherals are likely later.

Newbury Laboratories

The NewBrain, made by Newbury Labs in England, rated a spot in last month's "What's New in Electronics." Plans are to have it available here by January or February.

At 10¾ by six inches and weighing three pounds, the NewBrain is larger than the others. Reason: It has a full-size typewriter-style keyboard that allows fast touch-typing.

The NewBrain comes in three models. Model M uses line current and has no display. Model MB uses line current, but also has rechargeable batteries; thus you can use it for short periods in the field. It has a one-line, green fluorescent display of 16 characters; it can also be used with a TV. Model MBS is similar to the MB, but has lower current consumption, so it can run for extended periods on battery power. British-equivalent prices are $376, $474, and $593; American prices haven't been set. All three models come with 2K of RAM. Additional memory modules can be added.

The NewBrain's BASIC includes floating-point decimal mathematics accurate to 10 significant figures, and all trigonometric and inverse trig functions.

Two cassette tape recorders can be used with the NewBrain, and the company makes a compatible printer. The computer has ports for various other devices, as well.

Commodore

Commodore expects to introduce a portable computer in January. Exact size has not been determined. "But it will fit easily into a briefcase," says Michael Tomczyk, marketing director. The Commodore will have a full-size keyboard. It will use line current and have no display.

The computer, code-named the VIC, will generate a color image on the TV screen. It will come with 4K of RAM available to the user, and will accommodate expansion memory modules. "To what extent hasn't been decided," says Tomczyk, "but I would say at least to 32K." The VIC will use the same BASIC used in Commodore's PET desk-top computers.

Commodore is planning to manufacture an inexpensive printer for the VIC, and either a cassette-recorder interface or a disk driver. In addition, the VIC will have a standard adapter, called an RS-232 interface, built in so that many existing peripherals, including the PET modem, will work with it.

Programs, on plug-in ROM capsules, are being developed. One, a game program, should be ready by January. Another will provide graphics, the company says. PS

Quasar portable computer uses an acoustic coupler/modem to telephone other computers. Panasonic's is nearly identical, but keyboard is arranged like a typewriter's; Quasar's is alphabetical. Panasonic will sell computer and selected peripherals in attache cases (Quasar may also). Both will sell separate modules.

MANUFACTURERS' ADDRESSES

Commodore Business Machines, Inc., 950 Rittenhouse Rd., Norristown PA 19403; **Newbury Laboratories Ltd.**, 68 Regent St., Cambridge CB2 1DP, England; **Panasonic**, One Panasonic Way, Secaucus NJ 07094; **Quasar Co.**, 9401 W. Grand Ave., Franklin Park IL 60131; **Radio Shack**, Tandy Corp., 1800 One Tandy Center, Ft. Worth TX 76102; **Sharp Electronics**, 10 Keystone Pl., Paramus NJ 07652; **Sinclair Research Ltd.** (U.S. office), 50 Stanford St., Boston MA 02114.

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Save the action with
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Lightweight, low-cost cameras put "movies" on tape for instant replay

By WILLIAM J. HAWKINS

My oldest daughter was to be in a school play. Perfect, I thought, for a video taping.

With the J. C. Penney system I was using, I could tape the entire hour-long show on one $13 video cassette. Not bad, considering that an hour's worth of film and processing for my super 8 movie outfit would have cost me about $150.

It's now all possible because of a new group of lower-priced home video cameras. Sure, color video cameras have been around for years, but at prices ranging up to $50,000, they were a little out of reach for amateurs. New home cameras may be a step down in size and video quality, but they are affordable—from $750 to about $1500. And even those prices are dramatically offset when you consider the cost of film versus tape. That doesn't include the cost of the video-tape recorder you'll need, but it's not like a projector that sits in the closet for months at a time. You can use it to tape TV shows.

Video cameras take an image and convert it to a color video signal that can be recorded on any video-tape recorder. Since there's no film involved, there's no processing. You get an instant playback right on your TV set. Made a mistake? No problem. Just rewind the tape—as you would on an audio recorder—and try again. Record the same scene over again as many times as you like using the same tape. There's no waste and recording time is limited only by your recorder—up to six hours per cassette on some machines (see "New Generation of VCR's," this issue).

Choosing a video camera, however, is not as easy as using one. Price is one consideration, of course, but nearly all makers offer cameras at competitive prices. Picking the right one depends largely on how you'll use it, the features you'd like, and what equipment—if any—you already own. Here's how you sort through the variety of models available.

Just a camera

Despite their sophistication, video cameras rely heavily on conventional camera optics. Instead of focusing an image on a strip of film, however, the lenses on these cameras focus light on the face of an internal vidicon tube that converts the image to electronic signals.

The lens used will have an effect on the type of recording you can make. Low-cost models, for instance, usually have a single-focal-length, 25-mm, f/2 lens. It's a standard lens with good quality, but it is limited—it has no wide-angle or telephoto capabilities.

The "f" number is a measurement of the "speed" of the lens—how much light it can gather. The lower the number, the larger its maximum aperture and the more light on the vidicon tube. An f/1.4 lens, for example, will provide twice the amount of light of an f/2. This means little if you do most of your shooting outdoors in sunlight. But as the light level goes down—say, if you move indoors—an f/2 camera will require additional floodlighting sooner than the 1.4.

Although more expensive cameras

do have larger apertures (f/1.8 seems to be about average), the most significant change is in the type of lens you get; it zooms. One twist and you capture the whole family in a wide-angle picture. Another twist and you zoom in for a long telephoto shot. The typical zoom ratio (wide angle to telephoto) is 6:1. Many of these cameras give you macro capabilities: Push a button and you can focus on something just inches in front of the lens—a postage stamp will fill the TV screen on playback.

If you're on a limited budget, or not into exotic stamp shots, the standard lens will do fine. And many cameras, such as JVC's economy model, use a standard C-mount for the lens—unscrew the lens and replace it with an upgraded one later if you wish. But if you're a photo fanatic, save a little longer for the better lens—the additional capabilities it offers are worth the wait.

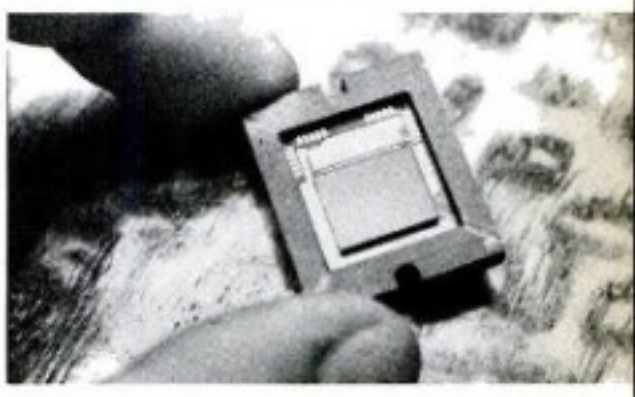
What you see is what it's got?

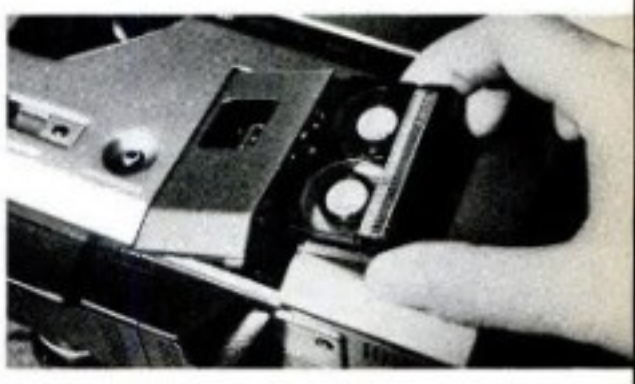
In photography, the human head can be decapitated without loss of blood—just a rise in blood pressure for

Continued

Sony's video camera of the future

It's five years away, Sony representatives claim, but the "video movie" is not just a dream—the working prototype shown here (facing page, and at right) is a complete video camera and recorder in one. Each miniature cassette (about the size of a microcassette, but twice as thick) holds up to 20 minutes of tape. Besides its smaller mechanics and electronics, one reason for its compact size is the use of a CCD chip (upper photo, far right) instead of a vidicon to sense a video image. Currently, the camera is placed in a home video editor (lower photo, far right) for playback on a TV screen or home recorder. Future versions may have playback electronics included. The total weight of the unit, including the rechargeable battery pack, is about 4.5 pounds.





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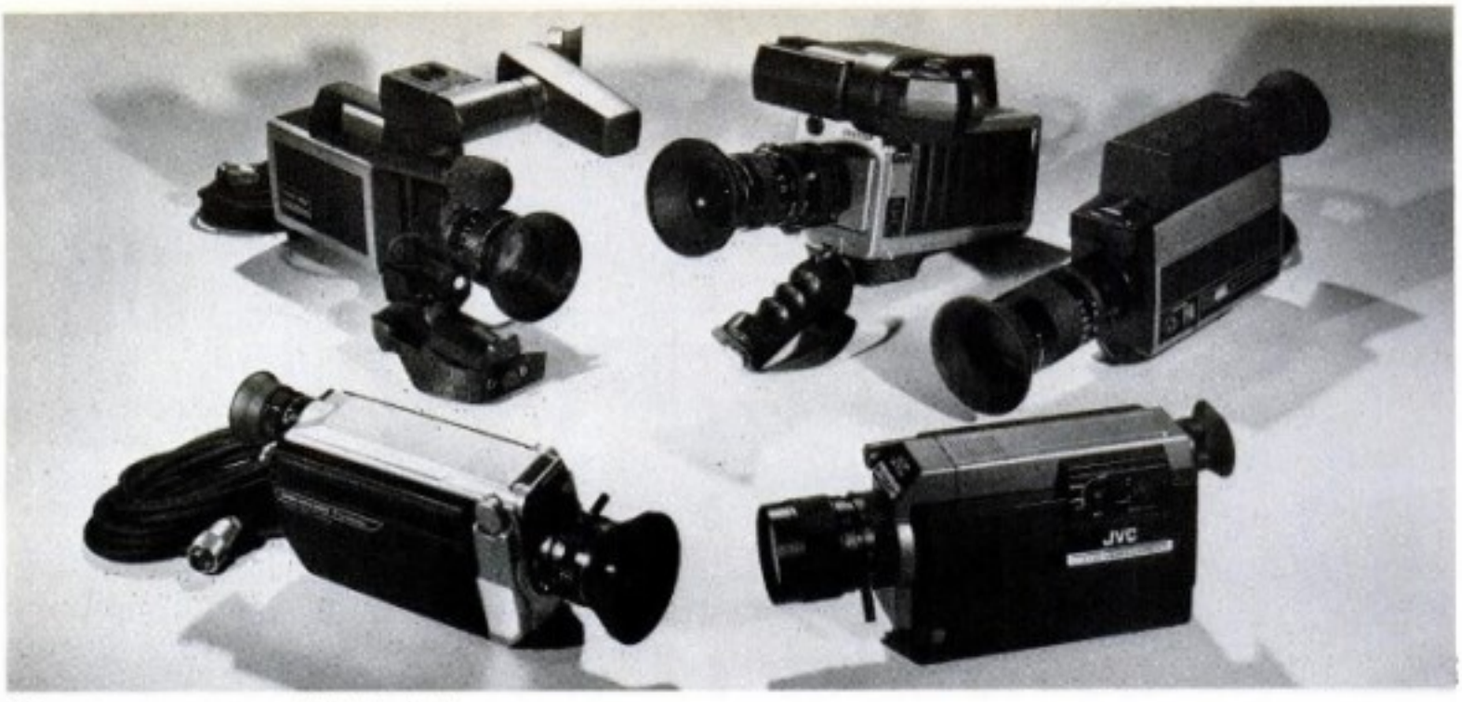

Video cameras now available include: (top row) RCA CC007; Sharp QC-35; Sears 53811; (lower row) Panasonic PK-530; JVC GX-66. Features such as Sears' color temp meter for proper tint and RCA's convenient swivel CRT help you make perfect tapes easily.

the movie viewers. Properly framing a shot is just as important in video taping. To do it, these new video cameras use one of three methods: optical sighting, through-the-lens, or electronic viewfinding.

The Zenith KC1000, for example, uses the sighting technique. You aim the camera by looking through a pop-up viewfinder and lining it up with a front-mounted sight atop the camera body. The angle between them sets the angle of the camera, properly framing the scene at an average distance. This works fine once you become accustomed to it (and you get plenty of tries since you can erase the video tape and use it again).

The through-the-lens systems (TTL) are a step up. On these—Panasonic's PK-530 is an example—the viewfinder is optically coupled to the front lens, giving you two advantages.

For one, you see precisely what the lens sees—framing becomes simple and error-free. And second, you can manually focus the image as your subjects move. With a telephoto lens, for example, this is a must.

For a film camera, a through-the-lens system is the ultimate. But for video, it's only "next best." Top-end cameras use an electronic viewfinder—a tiny 1½-inch black-and-white picture tube—to show you what's being recorded on tape. You look through a viewfinder equipped with a magnifying lens to see the CRT screen. Framing is simple, focus is precise, and even lighting is taken into account: If you can't see the scene on the CRT, it's not going on tape.

On some cameras, the CRT is mounted inside the rear of the camera body. Others, such as Sharp's QC-35, use an outboard CRT on one side of the camera. This allows you to move the camera in closer to your shoulder for easier handling and better weight distribution. RCA's CC007 uses the same idea, but the CRT will pivot—from left to right side—for minority groups. Being a "lefty," and favoring my left eye for viewing, I found this a definite plus.

The CRT can be used for other things, too. Throw a switch on the Sony HVC-2000, for instance, and you see a display of the video waveform to help you set light levels. And one big advantage of a CRT viewfinder has nothing to do with recording—you can use it to play back a tape, as well. While some scenes just can't be reenacted—like the night my three-year-old daughter fell asleep in her bowl of spaghetti—most can. Rewind the tape you just made and play it back through the camera. You see the scene—good or bad—in the viewfinder. If there's a problem, record it again. Great, but there is one catch.

Without a special connector cable (which may or may not be available), most cameras cannot play back a tape unless it's attached to a compatible VCR (usually the same brand). There are exceptions, however, such as Sears' 53811, which has a video IN connection as well as the conventional video OUT for recording. If you're buying a camera only, be sure it is totally compatible with the VCR you're using.

LED's, dials, things to try

All video cameras have circuitry that can compensate for a vast range of lighting conditions. But, in extreme changes, additional controls let you help it along.

When our eyes look at the color white, for instance, we see white, whether it's in bright sunlight or a dimly lit room. To a vidicon tube, however, color depends upon the color temperature of the source. A white color can turn reddish or bluish to the camera, depending upon whether you're shooting outdoors in sunlight or indoors under standard lighting. To compensate for it, all cameras have some sort of tint control (like the color tint control on your TV). Knowing

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New-generation VCR's

—smaller, lighter portables, feature-packed home decks

Microcomputer flexibility, soft-touch controls, stereo, and more—all for '81

By JOHN FREE
PHOTOS BY JOHN KEATING

New table-model VCR's on dealer's shelves this fall are slimmer, with distinctive, ultramodern styling. And what's inside these new-generation video-cassette recorders—microcomputers for programming and switching logic, all-electronic tuners, soft-touch controls, new TV microcircuits—not only trims away VCR pounds and inches to make the new look possible, it also means more reliability and operating flexibility. Competition is bringing last year's high-end features, such as high-speed picture search and slow-speed and frame-by-frame advance, to under-$1000 models.

These technology advances and features appear in portables, too. Manufacturers have whittled about four pounds off some earlier battery models. Now, with an 11-pound portable and lightweight camera, you can tape on the go without straining under heavy gear. One new portable has a home-VCR first: stereo capability that adds an exciting new audio dimension.

The new lightweight portables, in

Continued

New breed of portable and home VCR decks—sprinkled with recent MCA movie cassettes—includes (clockwise from top) the Sharp VC-6800, RCA VET250, JVC HR-6700U, Quasar VA-520SE (an optional tuner) and its companion deck, the portable VH5300, Panasonic PV-1400, and Sony SL-5600.

For the '80's: a decade of wonders in home electronics

Look for 3-D TV, hand-held VCR-cameras, giant-screen TV, and noiseless discs

By JOHN FREE

Video. That word and its companion hardware dominated three home-electronics shows I attended this year. Exhibits brimmed with new videotape and videodisc machines, computerized TV games, accessories, mammoth earth-station antennas, an umbrella-size direct-broadcast-satellite antenna, and more.

Giant-screen TV, the most dramatic video eye-catcher, was everywhere, too, as the leaders in color TV finally entered the field: RCA showed its Hitachi-built front-projection console, and Zenith unveiled its pop-up screen, rear-projection console [PS, Aug.].

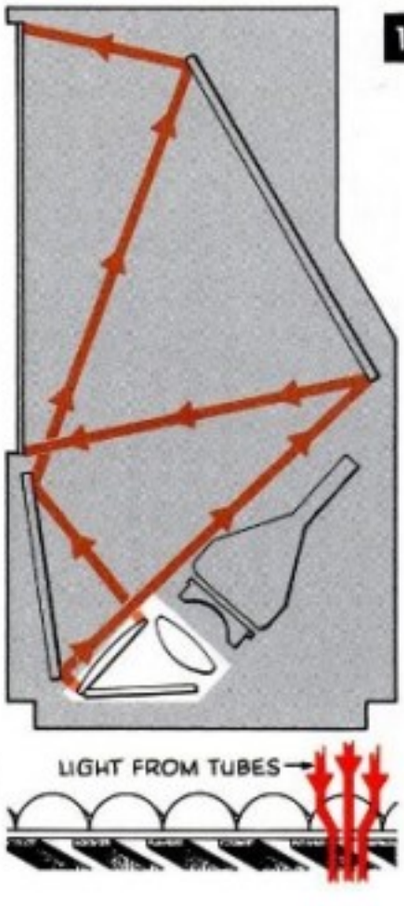
But significant new technology was also rolled out by Sylvania and Magnavox, both now owned by North American Philips. Sylvania's (1) and Magnavox's 50-inch rear-projection consoles have exclusive screens with narrow vertical black stripes on the front (see detail). The stripes absorb ambient light so you can have high-contrast pictures even in brightly illuminated rooms. Sylvania's 1981 SuperScreen model has a plump 41-inch-deep cabinet. But next year's model will be slimmer. A new mirror-lens system from U.S. Precision Lens positioned before each of the three projection tubes (diagram) will halve the cabinet depth.

Shrinking VCR's

Beta-format video-cassette tapes are somewhat smaller than competing VHS-tape packages. Now, Sony and other Beta-format firms have exploited this by totally reengineering their decks. Sony's SL-2000 portable deck (2, left), for example, weighs just over nine pounds and measures 8½ by 3⅛ by 12 inches. It can record up to five hours on one tape (one hour per battery charge).

But JVC and other VHS-format companies are readying a counterblow: a VHS mini-cassette a little larger than an audio cassette. Next year VHS firms will have portable decks weighing some 5.5 pounds. You'll be able to play one-hour VHS mini-cassettes back either with these compact portables or in standard VHS machines by slipping them into an adapter the size of a standard VHS cassette.

Meanwhile, for the next jump in size reduction—combination VCR-camera units—Japanese firms are trying to settle on a single tape format. Matsushita was showing its design entry (2, right) at its advanced-technology show in Chicago. This model is slightly smaller than an earlier one ["Look and Listen," PS, July], since the camera has a solid-state image sensor instead of a ½-inch pickup tube. Matsushita's micro video system puts two hours on a cassette slightly smaller than a standard audio cassette by using metal-evaporated tape.



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This high-density videotape is only 10 microns (millionths of a meter) thick—half that of VHS tape. These upcoming micro-videotapes are ¼ inch wide, compared with Beta's and VHS's ½-inch widths. One firm suggests a VCR-camera combo will be available as early as 1982. Next? How about still-smaller ⅛-inch tapes and hardware? Another Matsushita futuristic system at Chicago was a 3-D TV receiver (3) and a stereoscopic TV camera (4). The camera can record 3-D pictures on ordinary videotape machines and could be marketed soon.

The depth illusion is startlingly realistic. But you must wear special eyeglasses with photoelectric lens shutters synchronized to the images. There's some eye strain. Matsushita says the 3-D technique can be used with high-resolution TV [this issue], too. For 3-D TV in homes, though, many researchers are attempting to perfect a standard system that wouldn't require glasses.

Some audio components have a new look, too. Increasingly, you'll see turntables with nearly invisible tone arms—or arms mounted in "odd" positions. These are so-called linear-tracking models [PS, June '80]. They move the phono cartridge in a straight line across the disc—the way records are cut—instead of in an arc. This improves playback fidelity. And it makes exceptionally small, low-mass arms feasible.

Southern Engineering Products (Canton, Mass.) has developed a linear-tracking mechanism (5) with an arm that weighs only 1.3 grams. The tiny arm glides along a track of glass rods, driven only by stylus force in record grooves. The mechanism, a $500 turntable add-on, is said to have constant zero tracking error. By contrast, most linear-tracking turntables use electronic sensing techniques that continually play catch-up—adjusting tracking error back toward zero after it develops.

More low-noise LP's

CBS, the company that invented the 33⅓ LP disc, has introduced a new encoding scheme for records that sharply cuts surface noise and boosts dynamic range by 20 dB to about 85 dB. To achieve this, you need an add-on decoder like an MXR model I tried (6).

CBS calls its technique CX (compatible expansion). It's similar in principle to the dbx disc-encoding system [PS, March]. But unlike dbx discs, which sound very muffled if played without a dbx decoder, CBS's CX discs sound normal on hi-fi systems without a decoder. You just don't benefit from reduced surface noise and expanded range. CBS notes, though, that CX is designed for "minimum audible pumping"—the "breathing" sound that has plagued some compression-expansion techniques such as this.

CBS has equipped all its mastering facilities with CX encoders. Also, RCA and the multi-label WEA group have adopted the process—with more disc firms expected to join. CBS is offering the technology on a royalty-free basis.

A listening test with a new release, Korngold's opera "Violanta" (CBS 35909), demonstrated the total lack of surface noise and dramatic music peaks typical of dbx discs. Yet with the MXR decoder switched out the discs sounded normal.

Unless you look closely at one of the newest hi-fi components starting to appear (7), you'll think it's just another cassette deck. Actually, it's a "casseiver"—a combination deck and hi-fi receiver. Several firms have introduced their own. This JVC $650 model R-5000 includes two speakers. As microcircuits encompass more hi-fi functions, component integration like this becomes easier. You don't have to pay extra for separate chassis and power supplies.

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The coming
record revolution.
digital
discs
SONY
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SONY DIGITAL AUDIO DISC SYSTEM
MICRO DISC
TITLE

Video doorbells
show who's knocking

Now closed-circuit security systems are more affordable for homeowners

By JOHN FREE

A doorbell rings at a home in Detroit. "I'll get it, honey," a woman tells her husband. Peering through curtains, she notices a man with a package.

"Special delivery, ma'am," is the reply to her query. A chain latch is slipped into place and the door opened slightly. Is that an honest delivery man? Or will a shoulder slam against the door to throw it open, snap the chain, and admit armed intruders?

Such intrusions are a growing reality in many areas. In multifamily buildings, where residents can't see the entrance and must use an intercom, a criminal's entry ploy may be easier. But more and more apartment buildings, offices, and homes have a form of security once limited to the wealthy—video door-access controls.

New, under-$2,000 models of video door-phone systems—in effect, video doorbells—let you both see and talk to visitors before admitting them. And similar do-it-yourself systems based on modified conventional black-and-white-TV receivers have been available at under $500 for a few years. New technology promises more-versatile, lower-cost systems.

Continued

Call button on outside section of Unisonic 7700 Video Doorphone system (inset) actuates a built-in TV camera and three-watt lamps. Indoor unit chimes and visitor's image appears on 2½-by-three-inch black-and-white CRT. Telephone-type handset lets you talk over intercom—if you're "in" to visitor. Indoor unit can actuate camera, as well.

Three-button control (inset, top) enables homeowner to see and talk with caller at front door on Zenith Video Sentinel and GBC Look-Out systems. Doorbell intercom box (above) actuates the bell and switches TV from broadcasts to camera.

"Europeans are very security conscious, and this equipment is standard there," says Mark Goldberg, sales manager for Lee Dan Communications, a Hauppauge, N.Y., security firm. "It's just starting to become popular in the United States," Goldberg said, indicating that European firms have altered the voltage of models so they can operate here.

Costlier all-in-one systems have a TV camera built into an entrance push-button panel. To prevent vandalism, the panel is usually metal and the lens has a clear Lexan cover.

Closed-circuit TV cameras for the systems often have wide-angle 16-mm lenses to deliver the best picture near the camera. You can push a button on the indoor panel for limited TV surveillance of the entire entrance area. Sixty- or 30-second timers shut the camera off automatically to conserve the pickup tube. Camera sensitivity should be automatic: Unisonic's new 7700 Video Doorphone system has a light sensor adjacent to the camera.

Besides a handset for the audio intercom, indoor panels include brightness and contrast controls for the CRT, a button for an electric lock, and volume control for a door chime. Closed-circuit setups often provide better picture detail than conventional TV receivers. The Unisonic system, for example, has 450-line resolution.

Surveillance systems based on modified small-screen receivers, such as Zenith's and GBC's, are less expensive. They have both advantages and disadvantages. A 12-inch set in the kitchen may be inconvenient at times as a video doorbell. The set, with additional cameras, can be used to monitor a child's room or pool area. But an entrance-way camera is a tempting target for vandals or thieves.

New consumer-electronics components, such as tubeless, solid-state TV cameras ["Chips That See," PS, Jan.] and flat-panel CRT's, should enhance future security systems. For privacy, low-cost microcomputer chips in future models can provide coded-number operation: Visitors will have to enter the right code to ring your video doorbell. ■

FOR MORE INFORMATION

Local sources for video door-access controls and installations can usually be found under "security" in the Yellow Pages telephone-directory index.

To obtain the names of dealers for systems mentioned, write: **GBC Closed Circuit TV Corp.**, 315 Hudson St., New York NY 10013; **Sampo Corp. of America**, 1050 Arthur Ave., Elk Grove Village IL 60007; **Sanyo Electric Inc.**, Communications Products Div., 1200 W. Artesia Blvd., Compton CA 90220; **Unisonic Products Corp.**, 1115 Broadway, New York NY 10010; **Zenith Radio Corp.**, 1000 Milwaukee Ave., Glenview IL 60025.

For dealers using Entryscan, manufactured by Elettronica Industriale Milano (20035 Lissone, Via Filippo Turati 7, Italy), write **Photo-Scan Associates**, 1325 S. Colorado Blvd., Denver CO; telephone (303) 758-8611.

The publication, *Security Distribution & Marketing*, 5 Wabash Ave., Chicago IL 60603, publishes a guide of security products and services called "The Source."

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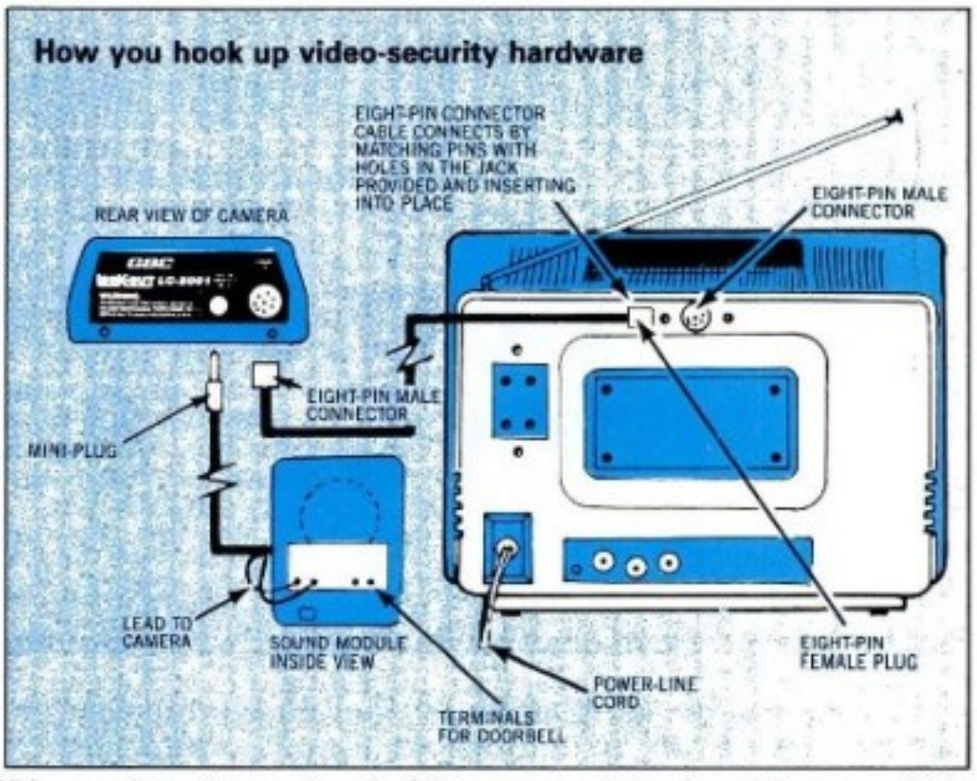
Eight-inch video screen and stylish design highlight the Italian-made Entryscan (marketed by Photo-Scan). This and similar systems have circuits to operate electrically controlled locks. Single-user Entryscan also has an optical alarm indicating when a door is left open by someone.



Video security systems, such as the $450 Look-Out 2000 from GBC and similar Zenith package, can be installed by most do-it-yourselfers or by a dealer. Hookup requires connecting 50 ft. of eight-wire cable between the 12-in. black-and-white TV and the automatic-light-compensation camera. Extension cables are available. The small sound module is installed between doorbell wiring and TV camera. Pressing button on sound module automatically switches set to the picture the camera is transmitting and rings the doorbell. An accessory ties in more cameras.

TV that extends security beyond entrances

Security TV monitors for your home let you keep an eye on things from a central location. At some sites, a video-only monitor may lack the flexibility of a system that lets you talk with visitors over an intercom as well as see them. But where an intercom already exists, an add-on camera may be all that's needed.

Sampo's Tri-Screen TV shown here is one way to combine entertainment viewing and security monitors in one location. The under-$1,000 receiver, marketed by American Express as well as Sampo, has a 19-in. color TV and two five-in. black-and-white screens. The smaller TV's can monitor additional broadcast channels or separate TV cameras.

Professional monitoring gear, such as that from Sanyo Electric Inc. and others, can deliver very-high-definition pictures. Monitor circuits provide good shadow details. Resolution of both cameras and TV monitors may be 600 lines or more. Cameras with semiconductor targets, such as Sanyo's 3500 series, are immune to intense light and have very low lag—no trailing "ghosts" with bright lights on a dark background. Also, cameras are available that require only 0.009-footcandle minimum illumination. Some even deliver pictures by starlight.

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THE GREAT CHAIN-SAW-SHARPENING DEBATE

New powerful portables

–best buy in a personal computer?

Big computer power in a small, totable package: This Otrona Attache, for example, is no larger than a portable typewriter.

Small and low-priced, they can do everything the big boys can—almost

By GORDON MC COMB
PHOTOS BY GREG SHARKO

It looks like a suitcase—an unassuming rectangular box with a handle on top. Look again. Pop its cleverly designed latches and fold down the detachable front cover, and you're seated in front of a complete desk-top computer.

The newest computers are pack-'em-up, pick-'em-up portables that go with you. No, these are not the hand-held "calculator" types. (I'll cover those in a future issue.) These "suitcase-style" models are full-featured units—complete with CRT, disc drives, and standard keyboard—squeezed down to a portable size and weight. Carry one between your home and office, take one on your next business trip, or, using a battery-pack option, even compute while you commute.

But there's more to these units than just portability. Their small size, built-in convenience, and relatively low price tag (they start at $1,800, including software) make them an excellent choice for permanent installations at home or in the office. You

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Slip the keyboard under the Dynalogic Hyperion model and you're ready to go. System is compatible with IBM programs.

The two micro-disc drives in the Jonos Escort accept the new 3½-inch discs. Each holds up to 322,000 pieces of data.

need not devote half a room to your computer gear—just half a desk top. Or you can use one as you do a portable typewriter: When you're through, pack it up and stow it out of sight.

All of this is good news, but what about the bad? What do you give up for portable power? How do these models stack up against conventional desk-top computers at the same price? And how do the new machines compare with each other? Here's what I learned.

What you get

Normally, buying a computer is much like buying a car. You're quoted the basic price; then you find out about the options you'll also need. But the portable computers, in general, come complete with all the essentials. Take a look at what you get:

- A computer with a full-function, full-sized keyboard. That's extremely important for text entry and word processing. The Kaypro and the Chameleon, for example, use the same keyboard as in DEC's $1,800 VT-100 computer terminal. The other portables use keyboards of similar high quality. Most also have a separate 10-key numeric key pad for fast and accurate number entry. The keyboards are detachable from the computer for greater ease of use.
- At least one standard input/output connector (I/O port) to add external gear—modems, printers, plotters—without the need to buy special cables or expensive plug-in circuit boards (electronic interface cards). There are two types of standard port connections: serial and parallel. Several computers, such as the Kaypro, Mayflower, and the M6000P, offer *both* for even more flexibility. (The Mayflower, in fact, has two of each.)
- A disc drive or two—each capable of storing between 102 kilobytes (102,000 characters) and one million bytes. The larger the storage capacity, the easier it is to use the computer and the more complex the programs can be. Two units, the Courier and the Dot, use the newer micro-disc drives that can store an incredible 280 to 320K on a pocket-sized, 3½-inch disc. The other portables come with standard 5¼-inch disc drives; many are compatible with discs used in other machines, such as the IBM PC and Xerox 820.
- A five- to nine-inch CRT (measured diagonally), in white-, green-, or amber-on-black colors, capable of displaying up to 25 lines of 80 characters each. All but two of the computers allow you to add external monitors, although several, such as the Osborne and the Courier, require you to add special $40 to $100 adapters.
- A minimum of 64K internal RAM memory—enough to store about 40 double-spaced typewritten pages. That's more than enough for nearly every business or personal software package available today. What about tomorrow? Several of the machines, such as the Hyperion and Dot, can be expanded to 256K for even greater power.
- Finally, some units come with their own built-in printer and telephone modem to communicate with other computers over a phone line.
- And to entice you even further, many include their own bundle of $1,000+ worth of business-oriented application software. The Kaypro, for instance, comes with word-processing, electronic spread-sheet, filing, and spelling-checker programs—combined, worth $1,200. The price for both computer and software? Only $1,795.

All this means you can use a suitcase unit to write letters, prepare income taxes, do household filing, talk to other computers, program, calculate budgets . . . all the things you can do with the average desk-top computer—and often for less money.

Sounds like portable computers are too good to be true, right? Well, almost. You do give up some features normally found on desk-top computers. Check these pros and cons.

A close look

The largest screen on any portable is nine inches, which produces characters about 30 percent smaller than the 12-inch screens used in most desk-tops.

Some machines, like the Osborne and Mayflower, have a five-inch screen—a 60 percent size reduction. Those small sizes could give some people trouble. To alleviate this problem, many portables allow you to attach larger external monitors. But, of course, that destroys the portability of the computer and adds to its price.

The four IBM-compatible machines (see table), although technically ca-

Continued

For desk-top or on-the-go use, it's a

big-screen lap computer

The Kaypro 2000 has a 25-line LCD display, 720K microdisk drive, 256K memory, and detachable keyboard. Those features make it a powerful desk-top machine. But at 12 inches square with a battery pack and optional built-in modem, it's a handy portable, too.

By JIM SCHEFTER

I opened the lid on the small black-and-silver box to expose a full-size keyboard and liquid-crystal-display (LCD) screen. A hidden disk drive clicked on, and seconds later the screen filled with Flight Simulator's airplane cockpit. That complex program is the standard test of a computer's compatibility with the IBM PC. And the new 2000 lap-sized portable from Kaypro Corp. (533 Stevens Ave., Solana Beach, Calif. 92075), an 11-pound machine just now becoming available, passed without a glitch.

For carrying, the 2000 closes into a stylish 2.6-inch-high case about a foot square. For work, it opens into a foot-high cube that allows easy access to the removable keyboard. And in some ways, particularly cost, it outperforms the PC it mimics. The $1,995 Kaypro 2000 includes:

- Three-by-nine-inch LCD screen with a 25-line, 80-character display.
- 256-kilobyte (256K) random-access memory.
- Detachable 75-key keyboard with function and cursor keys.
- 3.5-inch disk drive formatted for 720K.
- RS-232 and RJ-11 connections for a printer or other peripherals.
- Software: MS-DOS operating system, GW-BASIC, word processing, and a business application package.

Unlike other LCD portables I've used, the 2000's display shows extremely sharp definition of text and graphics. A viewing-angle control let me adjust the screen contrast for a variety of lighting conditions. But as I stepped back to admire my work, the screen suddenly went blank.

"The 2000 has entered its standby mode because you haven't pressed a key for more than one minute," said David Kay, the company's marketing director. "To conserve the battery, power is only supplied to the memory to retain data. Touch any key, and the display will return."

With normal disk-drive use, the battery powers the 2000 for about four hours. It takes eight hours to recharge, but an AC adapter lets you keep working while you wait.

The disk drive is concealed under a pop-up lid at the inside rear of the base unit. The company chose Citizen's drive for the 2000, Kay told me, "because it's barely more than two inches high and can pack 720K onto a 3.5-inch Sony-type disk." At least 18 popular MS-DOS programs already are available on such disks.

"This is no down-payment computer that needs expansion for full capability," said Kay. Though the 2000 is ready to go when purchased, it can be expanded. Its memory can be increased to an incredible 640K, and an empty socket on its single board accepts an 8087 math co-processor for high-speed computations. Also, Kaypro offers an optional internal 300/1,200-baud modem. The 2000 is sold through local dealers, but more information is available from the company. PS

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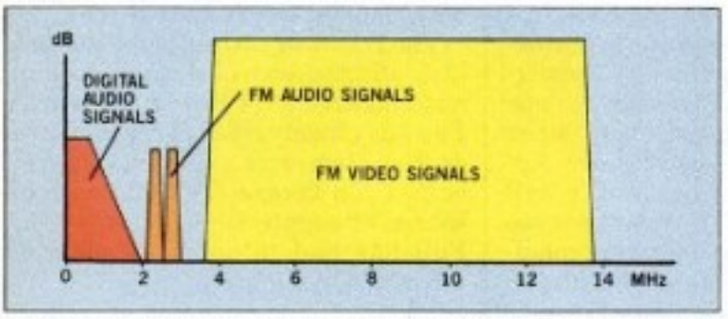
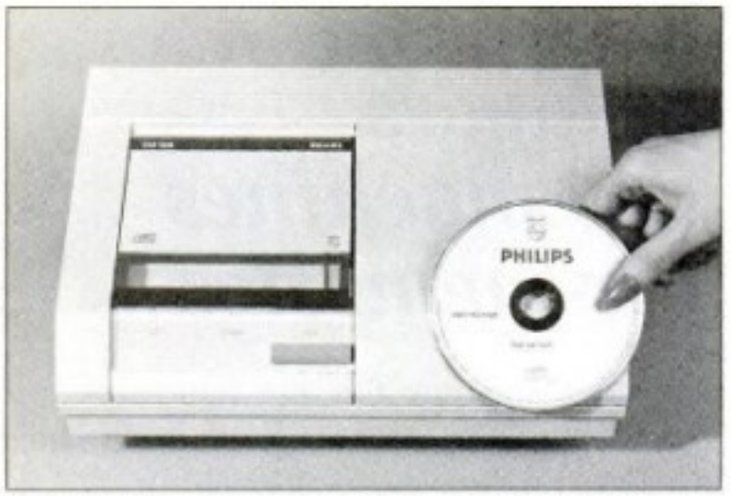
The laser-disc revolution

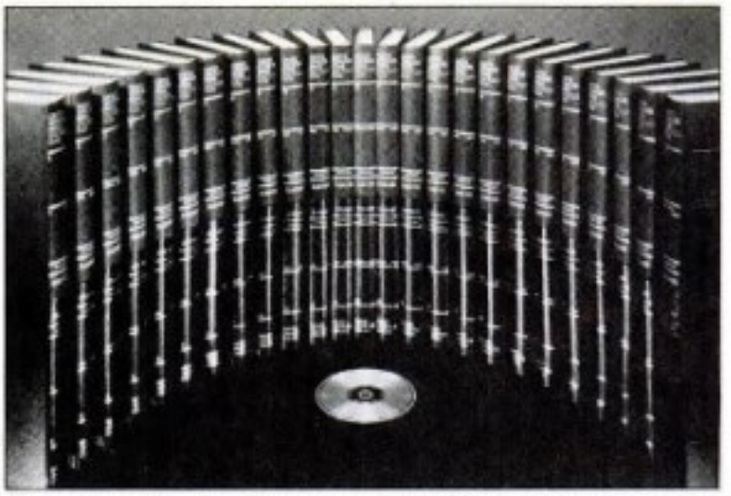
Squeezing digital audio onto videodiscs



Dual-use CLD-900 machine from Pioneer (above) automatically plays either eight- or 12-in. videodiscs, or 4.7-in. audio CDs. Output of a videodisc, graphically represented above, is a frequency-modulated (FM) analog signal carrying pictures and hi-fi sound. But super-fidelity digital audio, like that stored on digital CDs, can also be "piggybacked" on the FM carrier at frequencies below two MHz. A few new videodiscs with both digital and conventional (FM) audio are being produced for dual-use machines. Sony's ultra-compact D-5 is slipped into its $49 battery pack (right).



Compact-disc players from North American Philips and other companies are being built into computers and developed as peripherals. A single disc stores up to 600 million characters. Applications for CD ROM include storage of reference material such as encyclopedias for computer access. Encyclopedia set—minus pictures—fits on one disc.



not only play music but put graphic images and detailed text on your TV. And the hardware boom has produced an explosive demand for discs themselves: Owners of new players are snatching up twice as many CDs as expected. Disc plants can't meet the demand. As you might expect, stores that sell *only* CDs are popping up in several cities.

The CD-player boom, plus the combination machines for CDs and videodiscs, could renew lagging interest in LaserVision videodiscs for movies. At the same time, businesses and educators are discovering interactive videodiscs: Machines in banks, stores, travel agencies, exhibits, classrooms, and elsewhere display TV pictures from videodiscs. You can get information through still or moving videodisc images with a touch screen or keyboard.

CDs aren't revolutionizing just audio. At a recent Washington, D.C., conference on laser discs sponsored by Meckler Publishing (Westport, Conn.) I spotted some fascinating new hardware peripherals for personal computers: players for compact-disc read-only memories (CD ROMs). These laser-disc machines read the incredible amount of data that can be stored on a 0.7-ounce CD. They promise a new era in electronic publishing. In fact, computer-read data is already being published on laser discs: Some special videodisc machines can read 12-inch LaserVision discs that carry digital data instead of ordinary TV images.

All of these prerecorded CDs and videodiscs must be stamped out in ultra-clean disc plants. But other discs and machines now available let you record images or data anywhere and play them back instantly and repeatedly. These "read-write" optical discs can't be erased, although a family of erasable laser discs and recorders is on the way.

Research to exploit lasers for storing information on discs began in the 1960s. By the early 1970s N.V. Philips, a major Dutch electronics firm, was developing a laser-disc system to display prerecorded movies on home color TVs [PS, Dec. '72]. That disc system finally reached U.S. stores six years later as Magnavox's first LaserVision player [PS cover, Feb. '77]. Then, basking in the worldwide acceptance of its compact-tape-cassette standard, Philips unveiled its prototype compact-disc machine to handle music stored in digital form [PS, Oct. '79]. One year later it announced a CD standard, jointly developed with Sony. Meanwhile, dozens of firms were perfecting the more-elaborate laser-disc system needed to store the overwhelming amounts of data being generated by computers [PS, Aug. '82].

The whole field is based on the use of microscopically fine beams of pure light, switched rapidly on and off by a signal, to store information as patterns on the disc surface. A readout laser beam reflected from the patterns then restores the original signal. Ordinary white light won't do, explains Sperry engineer Ralph Schultz. "The laser is used because it has two essential characteristics: The light is monochromatic—it has only one wavelength—and the amount of light can be controlled at very high speed." Three basic types of discs have evolved:

Read-only. A laser at a manufacturing plant chemically alters a light-sensitive coating on a glass master disc. Etching produces pits, reproduced as bumps on metal stamping discs. Plastic is then injection molded onto the stampers, and the discs produced are coated with an aluminum film and protective layers. LaserVision videodiscs, audio CDs, and CD ROMs are made this way.

Read-write. Discs can be recorded on optical machines that have built-in lasers powerful enough to change the disc surface permanently: Pits or bubbles may form in heat-sensitive plastic or metal; a spot may become transparent instead of reflective. These nonerasable discs are used in a variety of data- and image-storing machines.

Erasable. Magneto-optic discs have magnetic particles that are aligned horizontally. When a laser surrounded by a magnet heats a spot on the surface, particles become vertically aligned at that point. This vertical field "twists" polarized light in the readout beam so the spot can be detected. Reheating the spot with the laser magnet off erases it because the surrounding horizontal magnetism realigns its particles. Another type of erasable disc uses an amorphous-crystalline material whose reflectivity decreases at points struck by a laser beam. A powerful eraser beam can restore reflectivity. Disc machines using both techniques have been demonstrated.

Micron world

The astonishing thing about these machines is that they work at all. Consider this: The laser beam in a CD machine—especially the car or portable units—must remain focused on a spot 1.7 microns (0.000068 in.) wide, centered on a three-mile-long spiral track of bumps that spin past it at up to 500 rpm. Slightly warped discs, off-center holes, or external forces because of movement can make this data track careen, with each disc revolution, hundreds of microns from where it should be. A tiny opaque speck of dust several hundred microns across on the CD's surface seemingly obscures hundreds of tracks, spaced 1.6 microns apart, beneath it.

[*Continued on page 107*]

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For-your-home video phones

Your phone rings. You press a button and *see* the caller. Press another button and he sees you. Phones like these once cost thousands of dollars and were designed for business purposes. Now, at $399, they're made for your home.

By WILLIAM J. HAWKINS
Photos by Greg Sharko

Peter Alpar in Melbourne, Australia, bought a vacation home in Queensland and couldn't wait to show it to his best friends back home in San Francisco. So he sent pictures of it through a VisiTel. "They loved it," he says.

Scott Cline lives in Pikeville, Ky., and his family lives in Winston-Salem, N.C. But VisiTel helps keep them together. "For my niece's first birthday party I felt as though we were there," says Cline. "It's not just a receiver stuck in your hand. It's more personal."

And in Santa Clara, Calif., Bill Brisko was naturally concerned when his father went into the hospital. "What made it worse was that I lived too far away to visit him," he says. So Brisko gave his father a VisiTel to take along. "That made a big difference," he says.

What's a VisiTel? "It stands for visual telephone," says Brisko, "You can *see* the person on the other end."

Brisko is not just an avid VisiTel user; he's also one of the Mitsubishi design team that created it. The clever box is something like a two-way TV set that works with your present telephone. Dial someone who owns a VisiTel, talk as you would normally. Then press a button. Your image is sent over the phone line, and the person you called sees a black-and-white still pic-

Mitsubishi's VisiTel above is turned on by sliding open the trapdoor that covers the ⅔-in. vidicon camera. Its 4-in. screen displays 2½-by-3¼-in. black-and-white still photos. Sony's Teleface (right) uses a ½-in. saticon imager tube.

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ture of you on his screen. And by pressing a button on his VisiTel, he sends a picture of himself back to you.

The idea isn't new: It's based on past slow-scan-TV schemes. And, of course, AT&T's Picturephone has been available for years. But those systems need special phone lines and cost thousands of dollars to buy or rent, relegating them largely to business users.

Now all that's about to change. Mitsubishi's VisiTel costs $399, works on your present phone line, and is made for home use. Sony, which has been selling a similar system in Japan since the fall of 1987, is expected to have its version available here soon. And other makers—such as Fujitsu, Hitachi, Matsushita, NEC, Sanyo, and Sharp—are rumored to be waiting to see if a low-cost video phone for the home will catch on.

How long a wait? According to the engineers and company representatives I spoke to, it's simply too early to judge. But if determination and enthusiasm count for anything, the future of video phones is quite a pretty picture.

Images from sound

"We engineered a phone that fits today's transmission medium," says Mitsubishi's Brisko. "We began by asking, 'What would it take to send a picture over a phone system that's already in place?' "

To a video engineer, the phone line is a limited information carrier. Its bandwidth is about 3.5 kilohertz. That means that 3,500 pieces of information can be sent every second. That's enough for a voice signal, but not even close to the 4.5 *million* a conventional TV picture requires. Also, because there are many phone systems with many different operating characteristics, the video phone had to be able to operate under a variety of conditions.

The attempt to develop such a device began more than 10 years ago. "Originally, this was an Atari project," says Brisko. "We started with programming and hardware made for the old video games and computers."

Not surprisingly, the team's solution turned out to be similar to the process of sending computer data through a phone line using a modem (see drawing). Here, however, the data represent picture information—96 by 96 pixels—which is used to vary the amplitude or volume of a 1,747-hertz tone.

To compensate for the phone line's limited bandwidth, designers had to trade off picture quality. "It's a black-and-white picture, with thirty-two shades of gray," says Brisko. But limiting the picture quality wasn't enough. More data were needed to create a complete image.

"We added a memory to capture incoming information," he says. "That lets the electronics build a picture over a period of time." It takes 5.5 seconds from the moment a picture is first sent until the last piece is received and displayed. That's not a long time, but it means you only see still snapshots of people, not a "live" picture.

Because each pixel is created by the level—the rise and fall of the amplitude—of the incoming signal, designers had to deal with the huge variances in phone-line quality. "We take care of that with a preamble," Brisko says.

A preamble is a tone burst sent to the receiving video phone just ahead of the picture. "When your video phone hears that burst, it knows there's a picture coming," says Brisko. "The circuitry knows how loud it should be, and uses the level it receives to set the incoming signal level." From then on, changes in level represent picture information.

The earlier work at Atari was sold to Mitsubishi, which continued the development. "The electronics for the first phone fit in an ice chest," says Brisko. Now, because of large-scale integration, most of that circuitry fits nicely on three main integrated circuit chips. "The largest one we call 'Mr. Bill.' "

Continued

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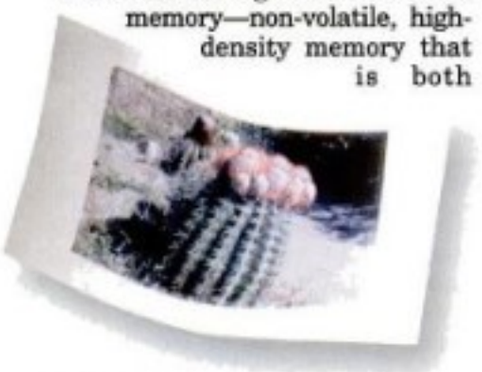
film—plenty for a bit of sightseeing.

The technologies that make this diminutive device possible are an improved still-image compression/decompression program (called JPEG) and solid-state storage known as flash memory—non-volatile, high-density memory that is both writable and erasable. The QV-10 contains 2MB of flash memory chips.



The notion that you can snap away without feeling guilty about wasting film takes some getting used to, though. There were the shots that got away, like the panorama above the airstrip just as that afternoon's plane was taking off. What was I waiting for? And as I lay on my beach blanket using the QV-10 to frame a bikini parade, I somehow forgot to click the shot. With the camera's pivoting lens and exterior screen, I would have been unobtrusive.

By switching to a macro setting, I managed to get within four inches of a pair of insects mating. I took another close-up of a stray cat who was stretching her head onto the leaf of a plant. By hiking to the island's peak, I was able to take not only wide-angle shots of other, nearby islands, but perfect close-ups of couple's names etched on rubbery almond leaves at the base of a lookout tower. Jungle graffiti ("Joe + Flo") filled my LCD.

Unlike those on other cameras, the Zoom button on the QV-10 is for use *after* you take the shot. Once you zoom in on a recorded image, you can move the enlargement window around. So, for example, I was able to crop out a bag in the cat picture and fill the frame with whiskers and leaves. Focusing in on the faces of a group of tourists sunning themselves by The Baths, a beach with stunning rock formations, I got up close by pressing the plus or minus keys to navigate around the scene. A "you are here" icon can be shown in the corner of the screen so you know which area is in view. Thus, the QV-10 not only eliminates the turnaround time it would normally take for pictures to be developed, but it puts the most common tools of post-processing—cropping and enlarging—right in your hands.

If you want to get in the picture yourself, you can simply hold out the camera, pivot the lens toward you, and watch your face flip automatically onscreen—a trick first seen on the Sharp Viewcam, a camcorder that also uses an exterior LCD instead of a private viewfinder. The shutter release can be delayed ten seconds while you and friends strike a pose.

At this point, my string of successful snapshots hit a serious snag. Where did I go wrong? If I had been prudent, I would have tried one of those low-cost single-use cameras. But the lure of parrot fish and coral compelled me to throw caution to the trade winds and take the QV-10 underwater.

I had brought along a submersible, transparent pouch to keep the camera dry. As I stepped off a dock with snorkel and sealed snapper in hand, a school of dartlike fish sped past. I managed to get off a few shots. So what if they weren't the most photogenic fish in the sea? Shoot now, delete later.

The camera was submerged no more than six inches. Normally, a message on the LCD says "Please Wait" during the few seconds it takes an image to be stored. But the message persisted. I returned to shore and pulled the camera from the bag. There were a few drops of water on the top of the casing, which I suspected were due to condensation. I turned the power off and then on again. The onscreen message wasn't so polite now. "Fatal Error," it wailed. My heart sank.

I'd been told by Casio that only three of these cameras were stateside, and now I had broken one. How could I explain dunking it like a stale bagel to the folks in Tokyo? Heck, what about my boss in New York? Even worse was fretting that my priceless vacation pictures had been obliterated. Sure, I tried changing the batteries. I'd occasionally turn on the camera, hoping for a miracle. But the message was always the same. What was one

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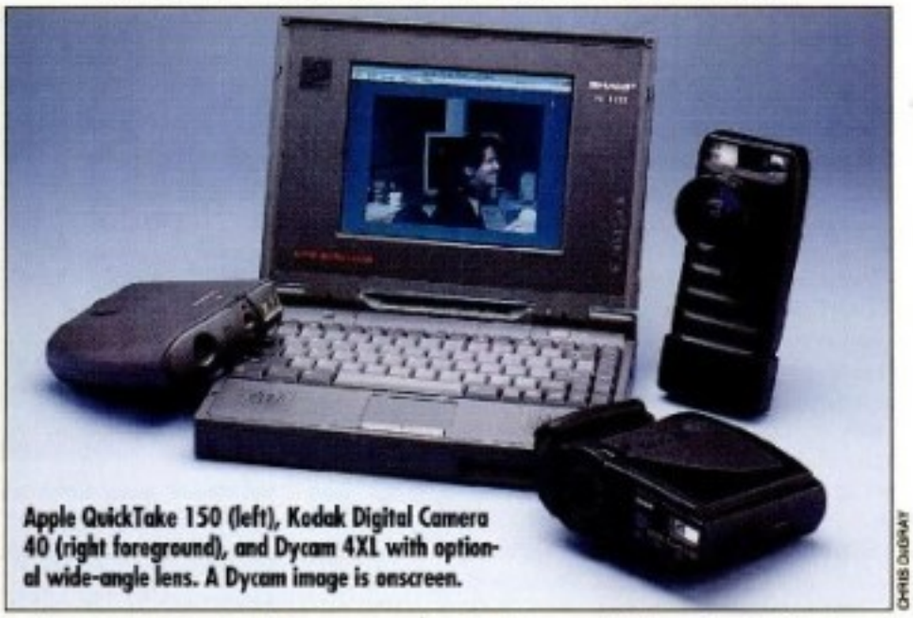
A HANDS-ON TOUR OF DIGITAL CAMERAS



Apple QuickTake 150 (left), Kodak Digital Camera 40 (right foreground), and Dycam 4XL with optional wide-angle lens. A Dycam image is onscreen.

CHRIS DiGRAY

As far as 24-bit color digital cameras under $1,000 go, models from Apple, Kodak, and Dycam produce spiffier images than the Casio QV-10.

Considered a benchmark by computer users, Apple's QuickTake 100 [see "Digital Cameras," Computers & Software Newsfront, Dec., '94] was recently replaced by the QuickTake 150. The only difference is a smarter compression scheme that makes it possible to shoot 16 high-resolution images rather than eight. The 150—like the 100—takes 32 standard images, contains 1MB of flash memory storage, and is priced at $749.

The QuickTake's charge-coupled device (CCD), a semiconductor that is used as an optical sensor to receive the picture before storing the image in the camera's memory, captures an array of 307,000 pixels—equal to the area calculated by multiplying 640 and 480, the dimensions of a standard VGA display. The CCD on the Kodak Digital Camera 40 produces an even higher resolution: 381,000 (756-by-504) pixels.

In contrast, the 1/5-inch CCD sensor in the QV-10 is capable of delivering only 115,000 pixels in a 480-by-240 array. The pixel count is less than a third of Kodak's. It's also less than the 181,000 (496-by-365 pixels) delivered by the Dycam Model 4XL. Through an algorithm called interpolation, which Casio expects to implement in its computer software by the time the camera ships, images will be enhanced when displayed at 320-by-240 pixels, which scales up to VGA-screen size. Still, they won't appear at full VGA resolution.

Unlike the QV-10, the Apple, Kodak, and Dycam cameras have built-in electronic flashes and accept optional lens accessories. The Dycam 4XL ($995) stores 36 higher-resolution images or 100 snapshots.

Curiously, the QV-10 has twice the storage capacity of the QuickTake. However, Casio decided to use its 2MB of flash memory for quantity (96 images) rather than giving users the option of increasing resolution at the cost of storing fewer images. Even if users could make such a choice, it would have to be predicated on Casio building in a higher-pixel CCD.

With its 4MB of flash memory storage, the Kodak Digital Camera 40 can capture 48 high-resolution images or 99 snapshots and is list priced at $995 (including Macintosh and Windows software and cables.) Images transferred to a Photo CD or output on a high-quality color printer begin to approach the quality of megapixel digital cameras costing thousands of dollars.—*M. A.*

comings. Landscape orientation is a prerequisite for showing images on a TV. If you shoot a portrait, the whole camera can be turned easily enough on playback. But on a TV the image will be sideways.

Like other LCDs operating in direct sunlight, the QV-10's picture is hard to see. I was forced to cup my hand around the screen to counter beach glare. A retractable hood is needed.

Alkaline batteries last slightly less than two hours. Since most of the power drives the display, it's unfortunate that there's no way to turn off the screen when images are being viewed on an external device. An idle camera does shut itself off.

Even for amateur photographers, the Casio QV-10 is not a replacement for less pricey, equally small still cameras. If you want to zoom in on an image before pressing the shutter, use a built-in flash, and rely on the neighborhood photo finisher for prints or slides, you'll need a film-based camera. When I brought the camera to a dimly lit restaurant, the absence of a flash made picture taking virtually impossible. (The LCD did attract the curiosity of the waiter and other patrons, though.)

Since the camera does not use removable media, you can't simply stuff the equivalent of a role of film in a mailer. What you can do is buy one of several video printers available, such as Casio's VG-100 ($499 street price). With the printer, you could, for example, output badge- and stamp-size labels and stick them on refrigerator magnets or business cards or put them in a photo album. The quality, however, is substandard compared to regular photos, and the cost of consumables (ink cartridge and special paper) is about 60 cents per 2- by 3.5-inch print.

The faster, less-expensive way to preserve highest-quality images is to transfer them to videotape. You could even add effects while copying the slide show by using the camera's playback controls to zoom in and around particular images or by deploying the multiple-image modes. You may want to add an audio track. My vacation slides now occupy the first seven minutes of a VHS cassette. Sure, I could have lugged a camcorder on the trip, but I wanted to travel ultra-light.

Gadget enthusiasts will gravitate to the QV-10, but the device is easy for anyone to use. Rather than pulling a wallet from her purse, for example, a grandmother traveling by plane could turn on the screen and hand the camera to the passenger in the next seat. ("Would you like to see a close-up of those baby dimples, dear? Press here.") A real estate agent could carry the camera as an ultra-portable image taker/storer/viewer for use in a car.

The QV-10's LCD is as sharp as any active-matrix display available. Pictures look terrific on the puny screen. The resolution on larger screens, though, is less than what you'd expect compared, for example, with a still frame from a good camcorder. Nevertheless, the Casio camera will likely win awards for miniaturization and versatility. Instantly viewable, zoomable, and erasable pictures and compatibility with computers and video equipment make the QV-10 a dynamic traveling companion indeed. ■

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to make of "Fatal Error" anyway? It was as cryptic as anything in DOS. At least when my Sharp Viewcam temporarily shut down while I crossed a humid Hong Kong Harbor last summer, the screen message was to the point: "Dew."

I hadn't been this devastated since hiking with a 35mm manual camera through Yosemite only to discover that the film had never caught on the take-up reel.

Because of this calamity, I stood to lose a perfect sunset, the single surviving image from a Darwinian delete-fest in which one image was unacceptable because it was too fuzzy, another too dark, a palm intruded, or the intensity of the sky's pink colors peaked two minutes after what I thought was the perfect shot. With a computer, you learn to back up your data. But who takes a computer on a vacation to back up a camera?

When I got home, I put the QV-10 aboard a 747 to Tokyo. My hope was that since flash memory didn't require power to preserve data, the images might still be intact.

A team lead by Casio engineer Hiroyuki Suetaka connected the camera to a DC power source and personal computer and transferred the data from the flash memory into the computer. By looking at the data pattern, they recognized an error in the allocation table, an address book that records where each image is stored in memory.

The reason for the "Fatal Error" message? Suetaka opened the battery compartment and discovered that the contacts had brown rust stains. Deeper within the compartment was a salty residue. "I think that some sea water got inside," Suetaka exclaimed. The resulting short-circuit caused an error in writing the data to memory. Then, once the microprocessor detected an error in the allocation table, it shut down and posted the "Fatal Error" message onscreen. Suetaka explained that this procedure protects the data that has already been recorded. If the camera had continued to record, pictures might have been lost.

Casio is changing the error message for production models. "The message 'Fatal Error' is not suitable," Suetaka said. The new message will be "Memory error, call tech support." Every technical support center will have the software to download the raw data from a malfunctioning camera.

Images seen on the camera appear simultaneously on a TV, as in this tic-tac-toe (nine-picture) mode. One or four images can also fill the screen.

The operation was a success, and the following week, another QV-10 arrived on my desk loaded with my repatriated vacation pictures. Casio included two floppy disks containing the back-up image files. Since you'll eventually have to delete some images from the camera to make room for more, the only way to preserve the digital files—the electronic equivalent of film negatives—is to move them to disk.

The camera has a number of short-

DIGITAL CAMERAS AND PERSONAL COMPUTERS

Tether the QV-10 to the serial port of a PC or laptop, and you'll appreciate the deftness of this Windows- and Macintosh-compatible camera. Using the bundled PC-Link software and cable, you can automatically download all the images in the camera to the computer. Pictures on the camera's display change in sequence, and thumbnails of the images then appear on the computer screen as an album.

Using a 486 DX4-based notebook, it took me 4.5 minutes to download 93 pictures. PC-Link enables you to simultaneously delete selected or contiguous images in the computer and camera, do a batch save to disk, or move images from the computer to the camera. By double clicking on one of the tiny computer images, you enlarge it to occupy its own window. The image is then treated as a separate file.

Though the prerelease software I used allowed images to be saved only in Casio's proprietary .CAM and Windows .BMP formats, the program will include two-way conversion capability to popular image formats such as TIF.

With the Insert Comment command, the software also allows you to attach a text window to an image (a way to caption, credit, and date a photo). You can also rotate images in 90 degree increments. Implementation of Twain, a Windows programming routine that allows users to scan images directly into popular applications, such as a word processing document, is lacking.

Nevertheless, for getting a quick and dirty color photo into your computer, the QV-10's instantly viewable images and 96-picture capacity in a package considerably smaller and lighter than anything else can't be beat.

Similarly, as a petite presentation device, the QV-10 will cause some people to leave their portable computers, floppy disks, LCD projection panels, portable photo CD players, or slide trays behind. As long as there's a TV with a video-in jack, you can use the QV-10 to transport your image files (originating in the camera or downloaded from computer) and use it to drive the picture show. All images are compressed in the camera to about 24K each. When you do have a computer and TV attached simultaneously to the camera, clicking on one of the thumbnail images on the computer screen manipulates the image on the TV screen. The pictures may not look as sharp as those from other sources—but that's the tradeoff.—*M. A.*

Images have been copied from the camera to the thumbnail album, but they can also be saved to the camera.

A Times Mirror Magazine

Popular science

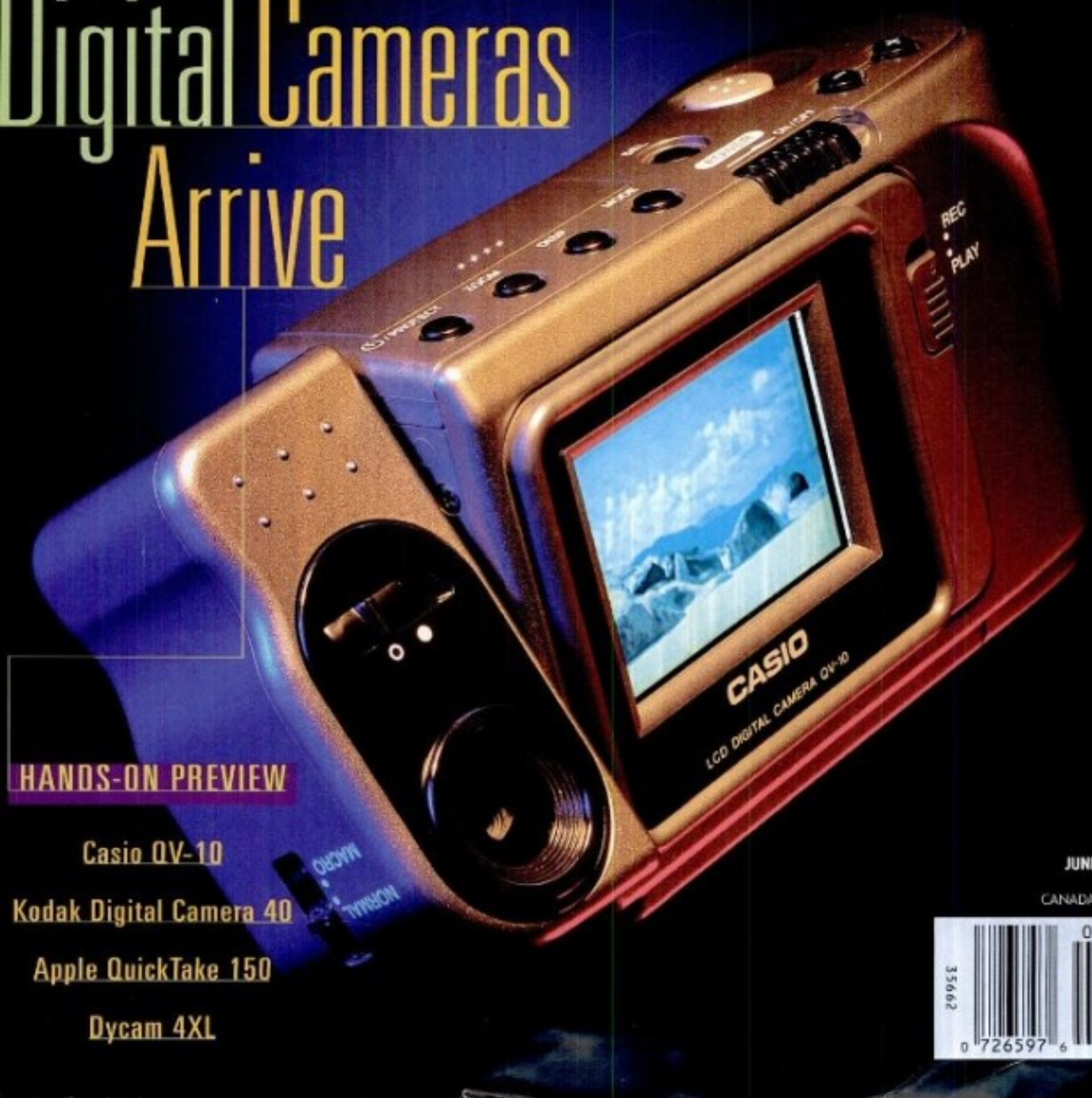
The Internet: Why Bother?

50 Ways To Save The Ocean Planet

Birth Of A Robot

THROW AWAY YOUR FILM

Digital Cameras Arrive



HANDS-ON PREVIEW

Casio QV-10

Kodak Digital Camera 40

Apple QuickTake 150

Dycam 4XL

JUNE 1995
$2.50
CANADA $2.95

06>
35662
0 726597 6

Within a few years, scenes like these will become commonplace, thanks to a revolutionary piece of portable technology: your cellular phone. Well, not your current cellphone. But the technology of the cellular phone—and the role that it plays in our lives—will be utterly transformed by something called 3G, or the so-called third generation of wireless telecommunications devices (after analog and digital phones). And if you think you know what it means to own and use a cellphone, you may have to clear your head. The 3G generation will come in a variety of shapes, sizes, and services, some of which hardly resemble the portable gabbers we know and love (or simply tolerate) today.

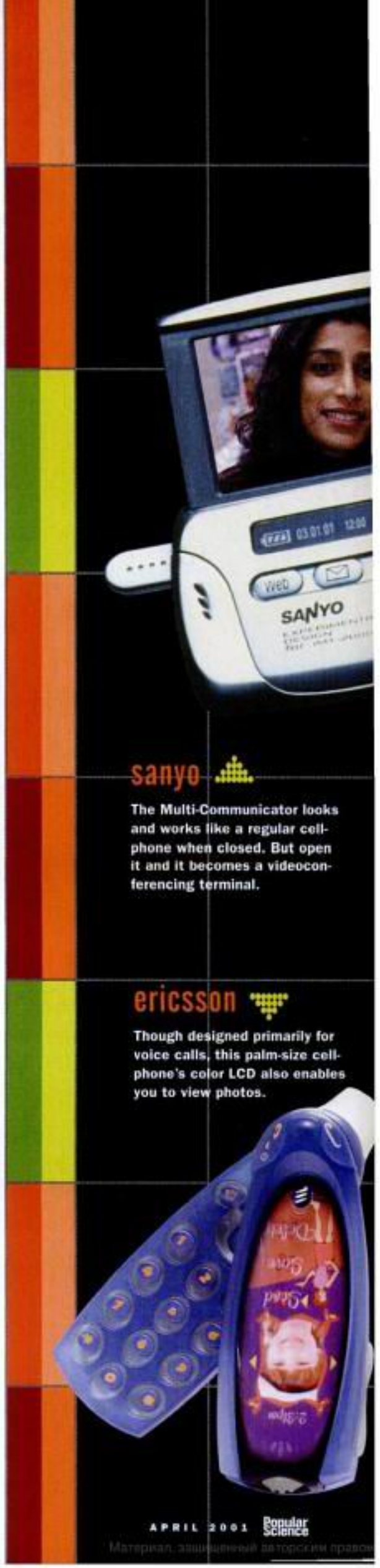
What exactly will 3G cellular mean? According to the standards already laid out by the International Telecommunication Union, 3G mobile devices will provide wire-line voice quality and very fast data rates for a wireless device—a minimum of 144Kbps, or roughly three times what most of us can squeeze out of a regular phone line with a 56Kbps modem. Those high data rates are expected to make practical a variety of audio and video services, such as music downloads, Internet radio, videoconferencing, and video e-mail. In addition to these functions, which will be provided via the new 3G networks, the pocket-sized devices we carry around will be packed with perks, such as color displays, removable storage media, and text-to-speech capabilities.

As with the changeover from first-generation analog cellular technology to second-generation digital technology, 3G's ramp-up from possibilities to realities will take some time. The first digital cellular phones of the early 1990s were large by today's standards and did just one thing: make or receive calls. Analog cellular modem cards did let you browse the Web with your laptop. But the phones themselves merely acted as dumb phone jacks. Today, you can purchase phones that are barely larger than chewing gum packs, can store hundreds of numbers, browse the Web, organize your day, and play MP3 music. The first 3G handsets will start out with these capabilities and go from there.

But there's work to be done first. The foundation for these new 3G handsets and services lies in the networks. Service providers, such as AT&T Wireless and Sprint PCS, need to upgrade their existing cellular networks to support higher data rates, locate individual users, and prioritize packets of information so they can move from place to place much faster. When the first 3G services roll out later this year from Sprint PCS, you'll be able to browse the Web or receive various information services at speeds up to 144Kbps, or up to 10 times faster than the carrier's current capabilities. At busy times of day, you could expect speeds of perhaps 70- to 80Kbps. Sprint PCS says its network, which will use the cdma2000 (code-division multiple access) standard, should reach top speeds of 307Kbps by 2002, and go as high as 3- to 5Mbps by late 2003. At these high speeds you could listen to an audio clip or view a movie trailer streamed in real time from a Web site. And your connection is always "on"—you're connected at the press of a button without any waiting.

Sprint PCS, of course, isn't the only wireless carrier that will supply 3G service. AT&T Wireless is building a new wireless network based on the GSM (Global System for Mobile communication) standard, which should begin operating in 2002 and gradually move in three steps from speeds of 115Kbps to 2Mbps. The final standard will be UMTS (Universal Mobile Telecommunications System, which some providers call Wideband Code-Division Multiple Access), which will deliver speeds of 2Mbps. To benefit from each of these speed bumps as they become available, whether from AT&T or Sprint or someone else, you'll need a new 3G phone. And with color displays on the outside and lots of gadgetry inside, such phones may not come as cheaply as cellphones do today.

In addition to increasing the raw speed of their data deliveries, 3G car-



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THE LOOK OF THINGS TO COME

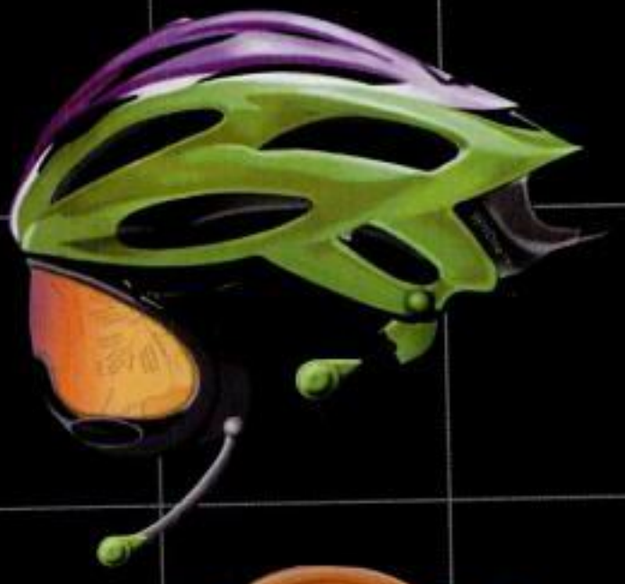
TRY TO CLEAR YOUR MIND of any preconceptions you may have about what a cellphone is. The multifunction devices that will work on next-generation 3G networks will come in a variety of shapes and sizes.

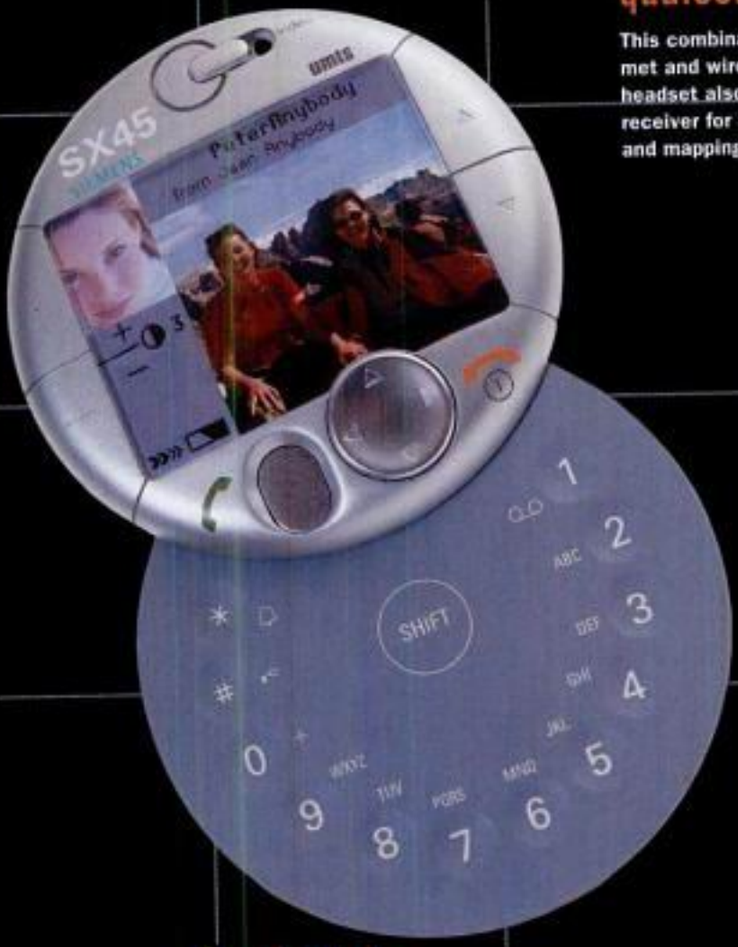
ericsson

Built for full-time use as a PDA, Ericsson's RX 1 doubles as a cellphone when you remove its wireless earpiece.

qualcomm

This combination bike helmet and wireless phone headset also features a GPS receiver for accurate routing and mapping information.





siemens

Hidden behind the SX45 videophone's sleek surface lies a surprisingly old-fashioned dial-pad design.

fujitsu

Rugged enough for the most hearty handling, Fujitsu's combination PDA-videophone makes its large color display the focal point.

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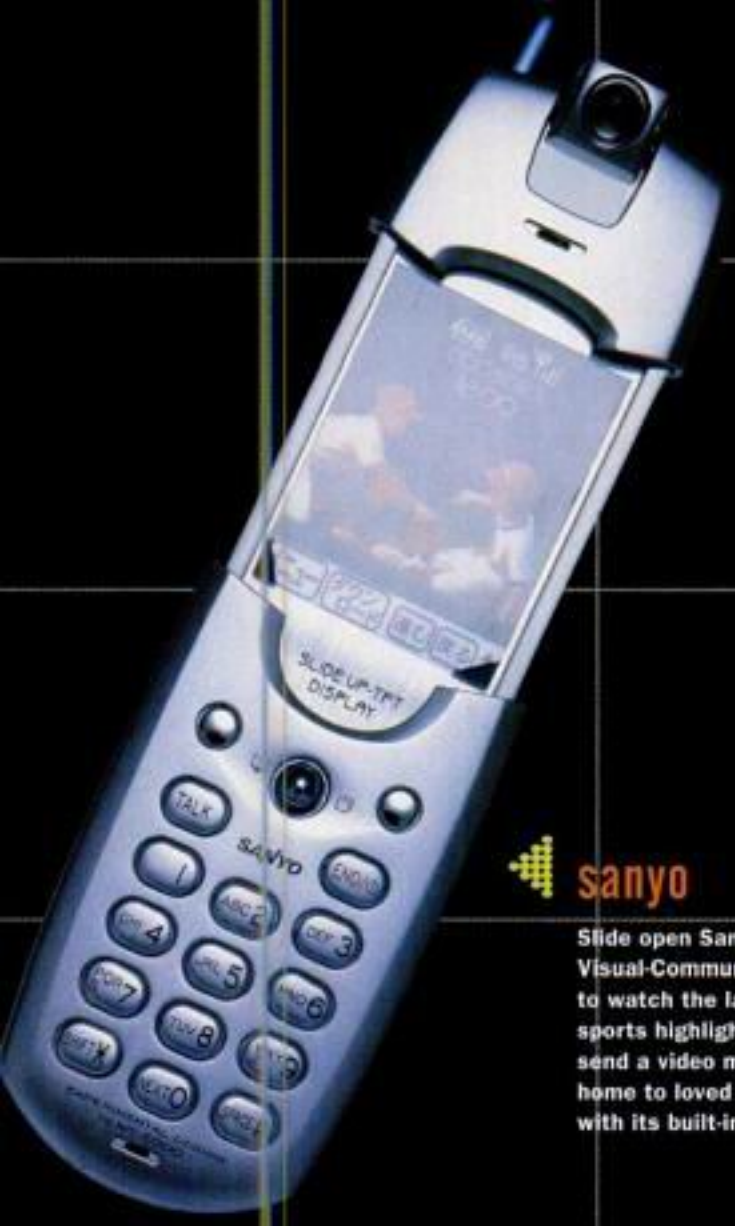


sanyo

Slide open Sanyo's Visual-Communicator to watch the latest sports highlights, or send a video message home to loved ones with its built-in camera.

A CELLPHONE TIMELINE

FROM BASIC VOICE service to full-motion video, cellphones have come a long way.

1st Generation 1980s

Bandwidth Required 3Kbps

- Connection to laptop

2nd Generation 1990s

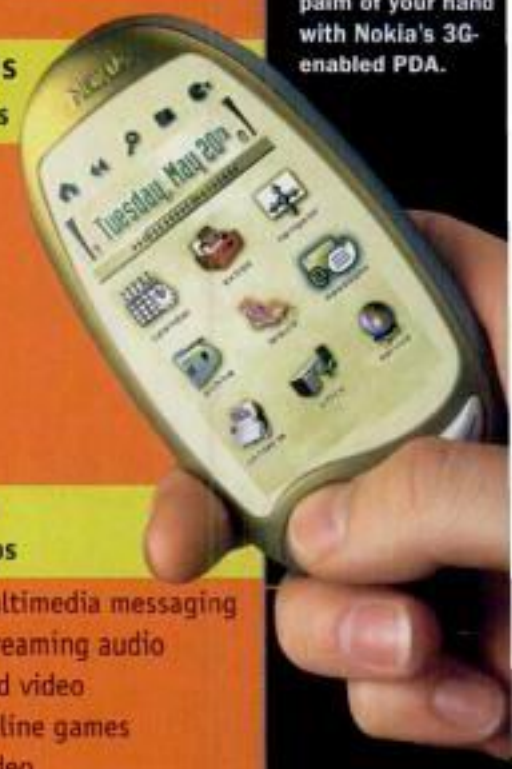
Bandwidth Required 9.6Kbps

- Messaging
- Basic Web browsing
- E-mail
- E-commerce
- Telemetry
- Vertical solutions
- Vehicle location

3rd Generation 2001

Bandwidth Required 384Kbps

- Full Web browsing
- E-mail with attachments
- Richer e-commerce
- Corporate intranet
- Multimedia messaging
- Streaming audio and video
- Online games
- Video telephony
- Music download



nokia

Put your e-mail access, Web browsing, calendar, and contacts literally in the palm of your hand with Nokia's 3G-enabled PDA.

riers in the United States are working on a means of prioritizing certain types of data, such as audio and video. Prioritizing seeks to properly weight the importance of speed to a given application—while you might be willing to wait a couple of extra seconds for an Excel spreadsheet to download, for example, any delays in transmitting a video clip can make for annoying viewing. A reliable method of prioritizing data packets will also enable carriers to split up voice calls into packets of data, instead of dedicating a full channel to each call. With packeted voice calls, the carriers will be able to handle at least twice the volume of calls, which will mean fewer times when you can't place a call due to an overloaded network.

Another key network technology of 3G will be its ability to pinpoint your location to within 50 meters. This capability was mandated by the FCC so that 911 operators can dispatch emergency services to callers who don't know where they are. But armed with your location, carriers could also offer all sorts of location-based services, including driving directions, a list of the closest gas stations, and coupons for nearby retailers. There will, no doubt, be privacy issues associated with this aspect of 3G, but carriers are confident that by using an opt-in policy—in which you choose when or where or with whom to share location data—you will have some control over who knows where you are.

So what will your new 3G phone look like? Perhaps not like a phone at all. In fact, you'll likely have several 3G-enabled products eventually—a phone, an organizer, a game machine, a Web tablet, and maybe even your car. Unlike today's cellphones, many 3G devices will have a broad range of capabilities, including MPEG-4 video and MP3 audio decoding, voice recognition, and Bluetooth personal area networking—making them more akin to computers than phones. And the desire for bigger screens on these more versatile Web and video devices is apt to grow, so not all of them will be as small as your current cellphone either.

One thing won't change: You'll still need to mate your 3G phone with a compatible 3G service, since not all carriers will use the same underlying network standards to achieve their goals. (Initially, 3G devices will work on the cdma2000 and UMTS network protocols.) As always, you'll need to pay attention to the coverage map of your 3G carrier, as it will expand over time. Eventually, there will be combination phones that will work on different types of 3G networks, just as some multi-mode phones today can handle calls over analog, digital, and PCS systems. And with Europe and Asia also moving toward 3G systems, truly global phones may become more commonplace as well.

But first, carriers and phone makers will need to produce on 3G's more basic promises, which have been talked about for more than a decade now. That, finally, should happen soon. Then it's your call.

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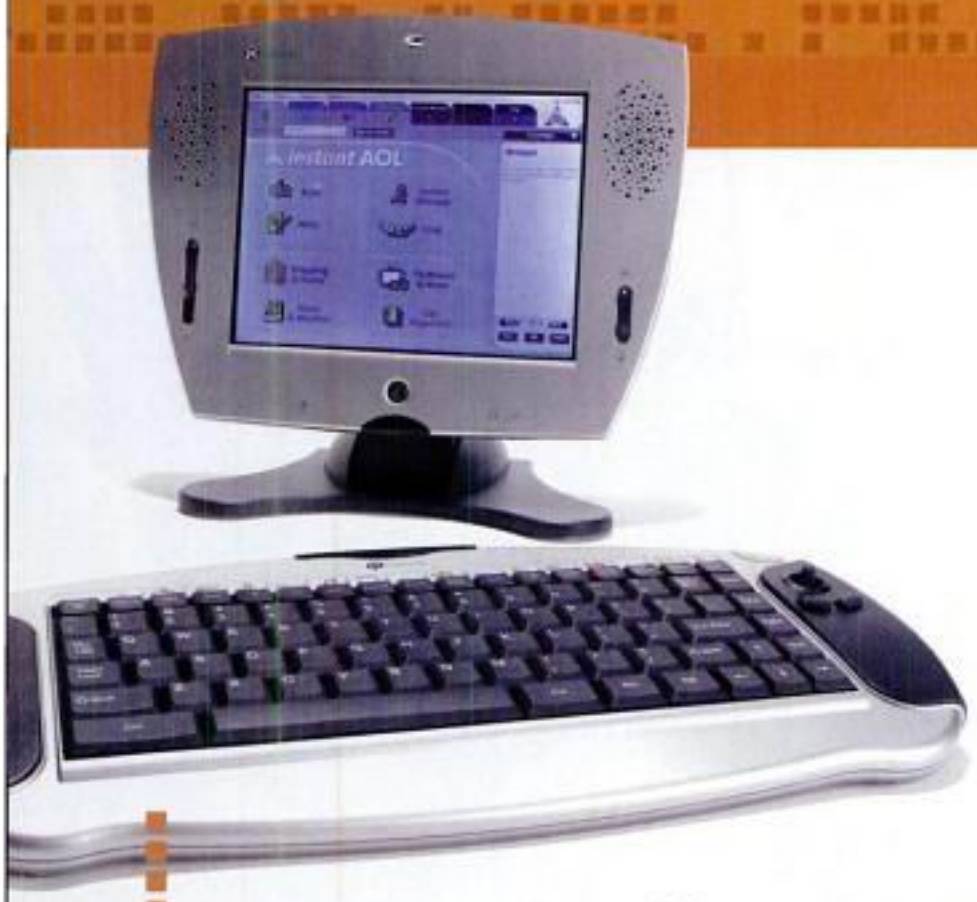
Every fall, hundreds of thousands of technology-obsessed visitors descend on Las Vegas to turn the gamblers' paradise into a 24/7 Nerd World.

By John R. Quain



Write-on PC

SONY'S TABLET VAIO N80 gives the personal computer a new twist with a tilting, crystal-clear, 18-inch LCD screen you can write on like a tablet with an electromagnetic pen. Sony has developed special Windows software that provides a dynamic rotating view of all your pictures and documents. Expect to see the N80 later this year for around $3,200.

You've Got Home Networking

INTERNET APPLIANCES were in force at Comdex, but foremost among them was the Gateway Connected TouchPad with Instant AOL service. Intended for the kitchen or den, the $599 device not only offers one-touch access to America Online's services but also can be used to control all the other computing devices in your home.

Cutting the Cables

WHAT DO YOU GET when you put a camera and a wireless modem in a pen? The Ericsson Chatpen, a stylus that magically makes handwritten notes appear on a computer or cellphone. Expected later this year for less than $200, the pen uses special paper and Bluetooth wireless technology. The Chatpen will join other products using the short-distance (under 30 feet) wireless technology, including a new line of Compaq notebooks.

CASIO
Cassiopeia

HANDSPRING
Visor

MICROSOFT
Stinger

KYOCERA
Smartphone

Cellphone or PDA?

CASIO and Handspring introduced add-ons that turn their PDAs into cellphones. Casio's battery pack doubles as a TDMA cellphone, while Handspring's GSM $299 Visor Phone clips into the Springboard expansion slot on its Palm OS-based handhelds.

Meanwhile, cellphones were also being turned into PDAs. Kyocera revealed its forthcoming Palm OS-based cell. It has a slimmed-down look but offers full-fledged organizer functions. Ericsson took the wraps off its sleek R380 World Smartphone, which has a flip-down dial pad that conceals a Web browser. And Microsoft's not-so-secret prototype Stinger cellphone was formally revealed; commercial versions are expected late next year.

Not Your Father's Notebook

TOSHIBA TOUTED several head-turning designs, including this ultrathin collapsible notebook computer. Still in the design phase, the Toshiba laptop features a

wafer-thin screen and a keyboard that slips back and up into the computer. For those who would rather read than type, Toshiba also inspired gadget envy with its vision of the next-generation of folding e-books (inset).

Tunes and Pictures

THE DIGITAL-MUSIC CRAZE inspired a welter of MP3 players at Comdex. Standouts were from Samsung, including the Multi Yepp—a prototype that also takes digital still pictures and can play MPEG-4 video—and the Baby Yepp (below), a locket-style music player that holds up to an hour's worth of music and goes on sale this year for about $150.

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By Christopher Miller

Gadget Fetish

Forget form following function. Tomorrow's electronics products are obsessed with their looks.

TAKE ONE PART reality, two parts imagination, and mix. This is the original recipe for producing new products, but now designers must add a healthy dose of entertainment and fashion to make tomorrow's technologies attractive today. No longer can gadgets be just functional—they must be sleek and chic as well. Product has become fashion, says Ravi Sawhney, CEO at RKS Design in Thousand Oaks, California.

Beneath these devices' glossy exteriors, the technology that will make them tick will be wireless radios—Bluetooth, wireless LAN, cellular—for connecting to data services at home and on the road. Anywhere, anytime communications is our future.

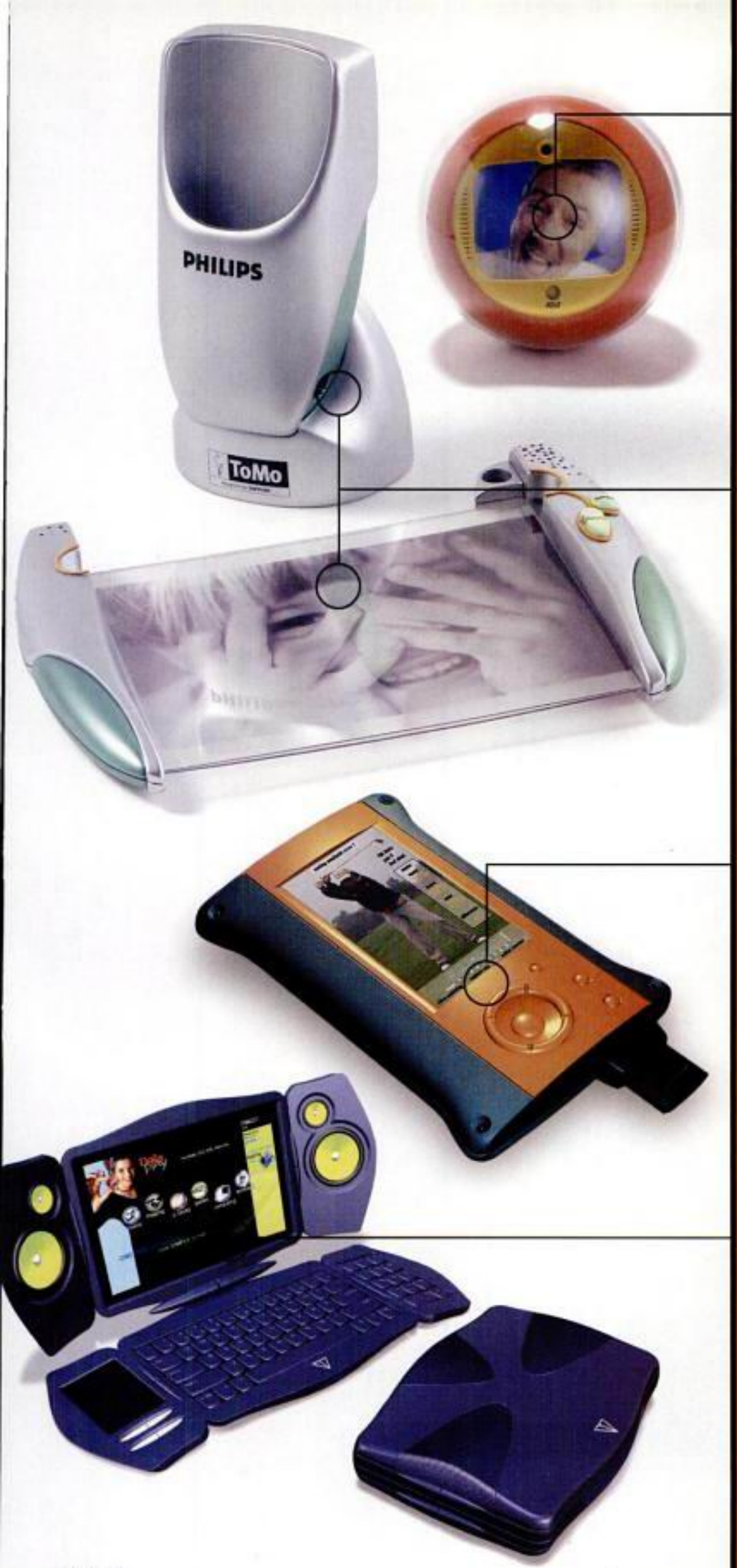
The likelihood that you will ever see these exact devices in production is slim. But you will carry, wear, or display products like them soon. Our future, it appears, looks good.

iRock Your World

DEVICE: iRadio

DESIGNER: Pentagram

SUBTLE DESIGN CUES from classic AM radios accent the concept receiver of tomorrow: the iRadio. At your disposal would be every radio station in the world—including those broadcast solely on the Internet. Physically plug in the iRadio or establish a wireless Bluetooth link to your home's broadband Internet connection, and you're set. Tunes, talk, and news emanate from the ultrathin, clear speaker developed by THX in England.



On the Ball

DEVICE: **Kid-Ball**
DESIGNER: **Frog for AT&T**

AS TELECOMMUTING gains popularity, videoconferencing phones may come to replace today's ubiquitous cordless handsets. This basketball-sized "Kid-Ball" wireless videophone concept was designed with children in mind, but multiple balls can be used for videoconferencing as well. A video screen, camera, speaker, and microphone fit inside the ball. Dialing is as easy as saying the number.

Web in the Pocket

DEVICE: **Fiore**
DESIGNER: **Chen Sapirstein**

YOUR PDA OF THE future will also be an MP3 player, Web browser, and videoconferencing unit. Fiore has a flexible, retractable screen. When open, a camera mounted on the upper right side captures full-motion video as well as digital stills. Bluetooth connects you to the Web via cellphone or home broadband service. Or, connect the old-fashioned way—that is, plug it in. Holder-charger is shown above.

Go Golfing

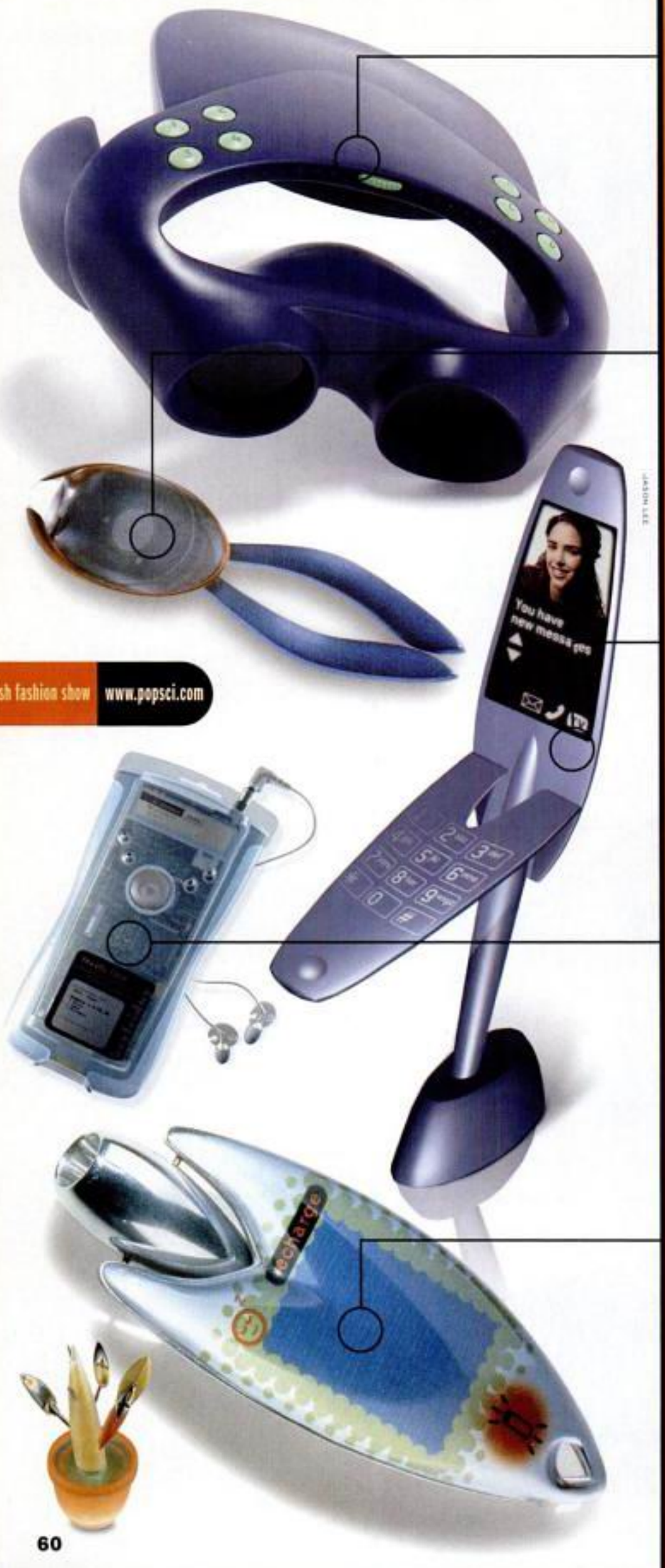
DEVICE: **Golf Buddy**
DESIGNER: **IDEO**

YOUR GOLF PARTNER may still laugh at your slice, but your Golf Buddy won't. This prototype palm-size advisor comes with built-in GPS receiver, camera, and sensors, which enable it to monitor your stance through your swing. You can even have your swing analyzed right on the course. On the fairway or in a sand trap, the Buddy coaches you through tough spots on the links.

Paperback Writer

DEVICE: **DataPlay Laptop**
DESIGNER: **Volan Design for DataPlay**

IN THE QUEST to make laptops even smaller, DataPlay's design is about the size of a paperback, measuring 5 by 7 by 1 inches. Much like a work of origami, the notebook's detachable track pad, number pad, and speakers fold out. Bluetooth lets you connect to your broadband service, and a built-in cellular modem provides a backup for connecting to the Internet.



Fetish fashion show www.popsci.com

Gamer's Delight

DEVICE: **Rover**

DESIGNER: **Ziba Design**

MUCH LIKE ADVANCED head-up displays the military uses, the prototype Rover lets you play videogames on the go. Pop a CD-based game in the top of the unit, put on the earphones, and look through the lenses to see the TV monitor. A gyroscope lets you view a 360-degree virtual world by moving your head.

Shop Quick

DEVICE: **Cameo**

DESIGNER: **Herbst Lazar Bell**

HATE TRYING ON clothes? In the future, you won't have to. Just input your picture and body measurements into Cameo and hit the mall. See a shirt you like, but not sure if it's really you? Scan the bar code with Cameo, and watch as your body appears as a hologram with the shirt on. A few clicks more brings a matching tie.

Ultimate Flip-Phone

DEVICE: **Soho Stick**

DESIGNER: **DD Studio**

THE SOHO STICK is the next-generation cellphone. Actually, it's a cellphone and a virtual pen. Closed, the Soho Stick writes and scans text. When you're done scribing and scanning, flip open the pen to send your data. An LCD displays who's calling. Finish your day by charging the Stick in its "well."

Totable Tour Guide

DEVICE: **Boyfriday**

DESIGNER: **Lunar Design**

FROMMER'S AND LET'S GO travel guides may be extinct in a few years, in favor of a smart device like Boyfriday. Preprogrammed with your getaway itinerary, Boyfriday knows your likes and needs. Don't know where to eat? Just ask Boyfriday. What about that famous exhibit in Spain you wanted to see? Boyfriday shows the way.

Flower Power

DEVICE: **Zuzu**

DESIGNER: **Herbst Lazar Bell**

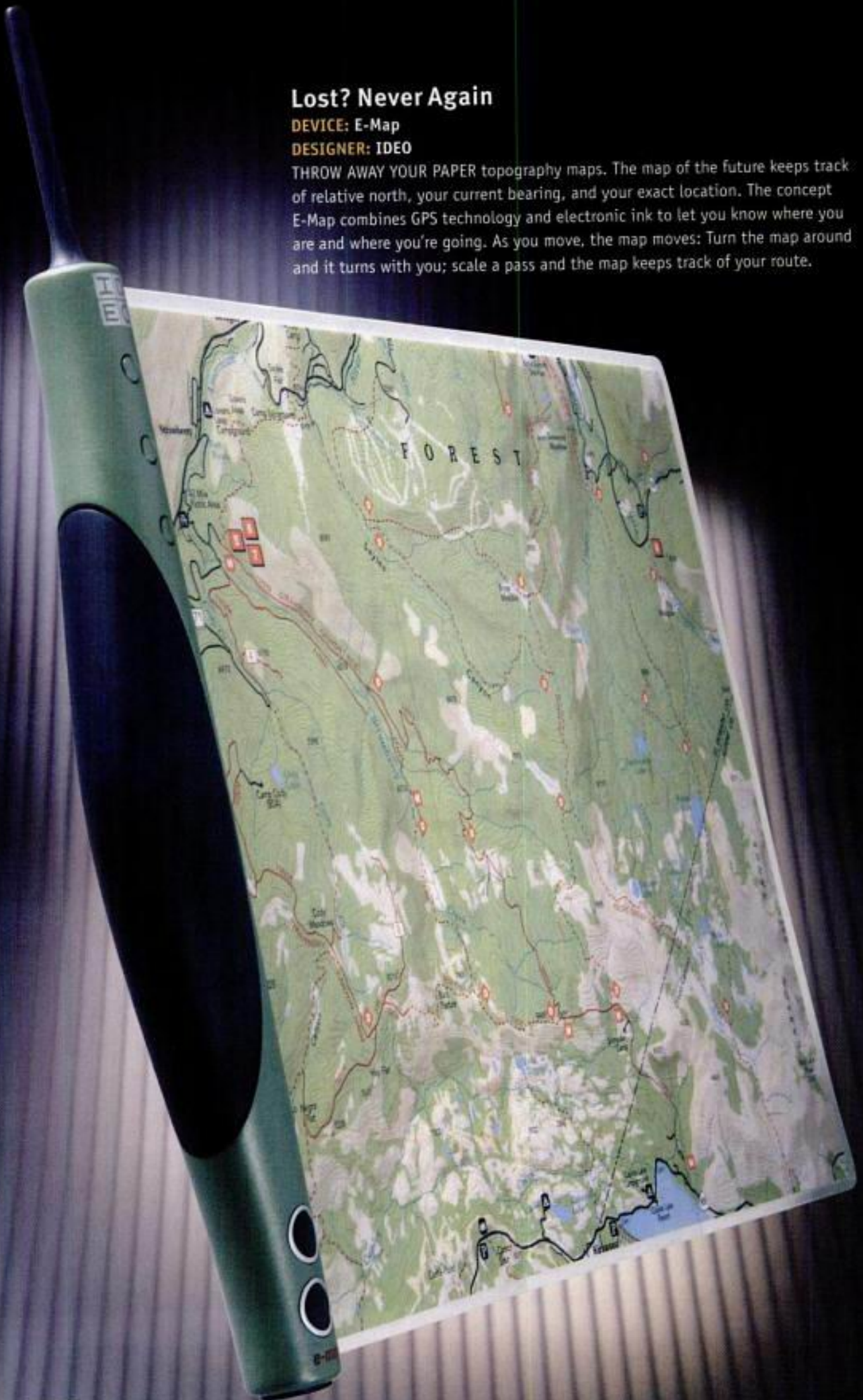
AS DIGITAL DEVICES become as ubiquitous as pens and paperclips, you need a desktop organizer—Zuzu. The prototype Zuzu comes with an MP3 player, digital camera, PDA, and docking station for the devices. Like a plant, Zuzu uses solar energy to recharge its leaf-like attachments. Just don't upgrade the pot with real soil.

Lost? Never Again

DEVICE: E-Map

DESIGNER: IDEO

THROW AWAY YOUR PAPER topography maps. The map of the future keeps track of relative north, your current bearing, and your exact location. The concept E-Map combines GPS technology and electronic ink to let you know where you are and where you're going. As you move, the map moves: Turn the map around and it turns with you; scale a pass and the map keeps track of your route.



Материал, защищенный авторским

New Cameras That Make Photography Easy

Cameras that autofocus, others that take 3-D pictures or some that use no conventional film at all make picture taking more fun than ever.

by Neil Shapiro ELECTRONICS EDITOR

For shutterbugs or camera buffs, there are new systems that put the thrill back into taking pictures. It's easier than ever to click the shutter for a fine photo to show off later. We checked out six cameras, using these new systems, and were impressed by the fine results and startling designs.

The Polaroid sonar-imaging system for automatic focusing is an integral part of the SX-70 and new Sun Camera we used. Kodak's new disc system makes the Disc 8000 camera a treat. A new method of electronic autofocus turns the Canon AL-1 into a 35-mm friend. The three-dimensional effect of the Nimslo is astonishing. And Sony's plans for the Mavica system of no-film photography sound grand.

Times have never been

Polaroid Sun 660

Polaroid SX-70

Canon AL-1

Sony Mavica

Nimslo 3D

Kodak Disc 8000

Handsome-looking cameras above help you take great shots. The Polaroids (Sun 660 and SX-70) have a sonar-ranging autofocus system. Canon AL-1 uses new, integrated-circuit technology for its autofocus. The Nimslo 3D takes three-dimensional photos on specially processed film. Kodak's disc system potentially puts easy-to-use cameras in everyone's grasp. In the meantime, Sony is trying to turn photography around with the Mavica all-electronic, filmless camera.

PM photos: Peter Tenzer

better. Looking at the Polaroid SX-70 or the new Sun Camera, one feature that stands out is the round, golden-grilled object just above or next to the lens. This device, called a transducer, is the heart of Polaroid's sonar-based, autofocus system.

The transducer can be considered a very accurate, four-toned speaker. Inside it, very thin, plastic film vibrates as voltage is applied and sends out tones of 60, 57, 53 and 50 kHz.

The sound waves bounce back to the transducer from objects they strike between about an inch and 35 feet away. The detected echoes are processed digitally, then the lens of the camera is adjusted to focus through analog circuitry.

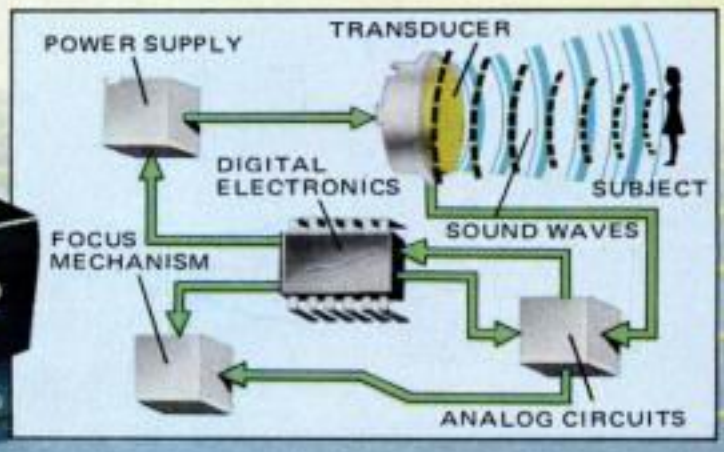
In use, the system was fail-safe. The SX-70 camera requires you to first depress the shutter partway in order to focus. The Sun Camera allows for focusing and shooting in one movement, though it sacrifices the SX-70's close-up abilities.

Every shot we took was in focus. Of course, there are certain shooting conditions to avoid. Obviously, you cannot focus automatically from behind a window, since the camera will focus on the window pane. Likewise, complex surfaces, such as leafy plants, could fool it.

But for everyday shooting, it couples the surety of autofocus with the quick gratification of develop-while-you-wait Polaroid film.

POLAROID SX-70

POLAROID SUN 660



CANON AL-1

Polaroid system of sonar-ranging (detailed above) uses a transducer next to lens. The transducer sends out sound waves, echoes of which are processed by computerized (digital) and normal (analog) circuits. The Canon AL-1 (left) uses charge-coupled devices to autofocus. Incoming light is split into three beams. Each hits a CCD and the camera's on-board microprocessor interprets results and suggests focus.

PM art: Jeff Mangiat

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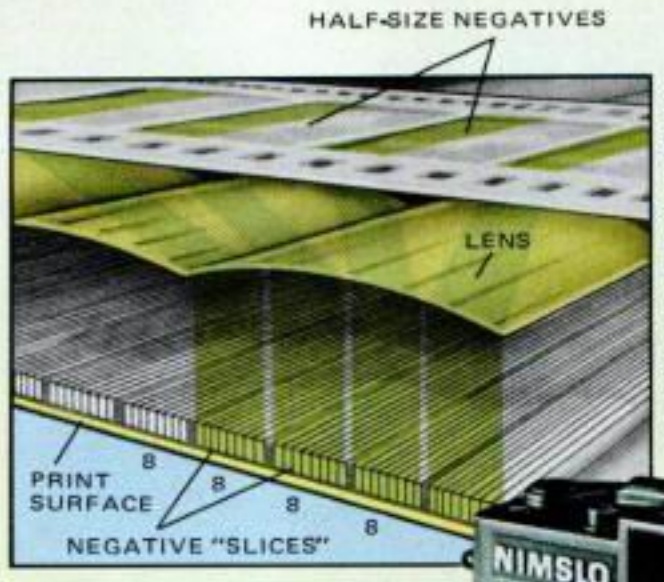
Split to focus

Canon's new system of autofocus departs dramatically from the sonar style. The Canon AL-1 is loaded with leading-edge, electronic technology in the form of three charge-coupled device (CCD) integrated circuits.

When you first pick up the camera and look into its ground-glass viewfinder, nothing seems unusual. But when you begin to focus on something and press the shutter lightly, the magic begins.

As an object comes into focus, three tiny indicators in the viewfinder guide you to focusing perfection. A left- or right-pointing, red

(Please turn to page 185)



Nimslo 3D's four lenses use half-size negatives. Each carries scene from different viewpoint. Negatives are sliced and arranged beneath lenses which cover print. Lenses blend image for 3-D. The Kodak Disc 8000 has new disc film, autoadvance, autoflash and great depth of field. Sony Mavica uses no film; it stores picture electronically in Mavipak.

NIMSLO 3D

KODAK DISC 8000

SONY MAVICA

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The bleak era of PCs in rectangular boxes may finally be over.

By Chris O'Malley

Radical Chic

Movable Feast

The tilting TFT (thin film transistor) screen folds flat when you want to move the computer, and there's space above the mouse holder where you can stow the keyboard.

FINALLY, A HOME COMPUTER you won't want to hide away in the spare bedroom. That's one reaction to Compaq's striking new Presario 3000 system, with its flat-panel color display suspended against a speaker-grille backdrop. Another reaction: Is this really a personal computer?

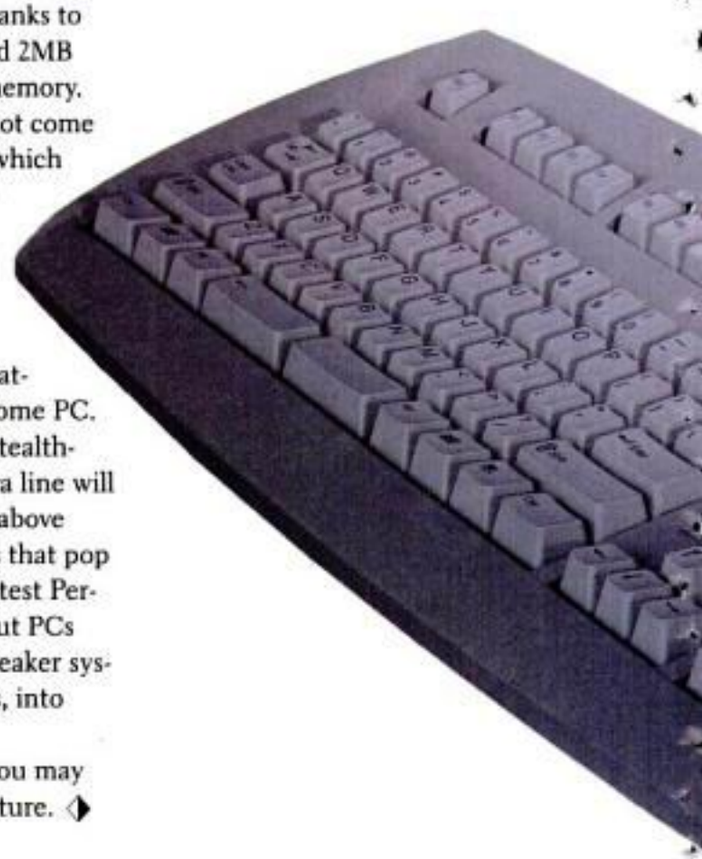
Yes, it's a PC, and a deceptively high-powered one at that. The first model in a new line, the Presario 3020 has a 166MHz Pentium processor inside, accompanied by 16 megabytes of memory, a 2-gigabyte hard disk, a 33.6 modem, a four-disc CD-ROM changer, and JBL stereo speakers with Spatializer surround-sound. There are even *four* expansion slots tucked horizontally in the rear.

But the sleek design is what really moves you—and moves with you. The Presario's slender shape, coupled with a built-in handle and holders for both the keyboard and cordless RF mouse, lets you quickly transport the PC from the family room to the kitchen. (You'll need an AC outlet, though; there's no battery operation.) And the 12-inch LCD screen is lustrous enough to work or play in any room, because of unusually bright dual-lamp backlighting. Video clips look remarkably smooth, thanks to MPEG software support and 2MB of high-speed videoboard memory.

Computer cachet does not come cheap. The Presario 3020, which comes preloaded with Windows 95 and a host of other software programs, is expected to sell for about $3,500, a hefty premium.

Compaq is not alone in attempting to redesign the home PC. Due in September, a new stealth-black model in IBM's Aptiva line will feature a monitor perched above floppy and CD-ROM drives that pop up from its base. Apple's latest Performa 6400 and Sony's debut PCs each integrate complete speaker systems, including subwoofers, into their hardware.

Heck, with these PCs, you may need to upgrade your furniture.



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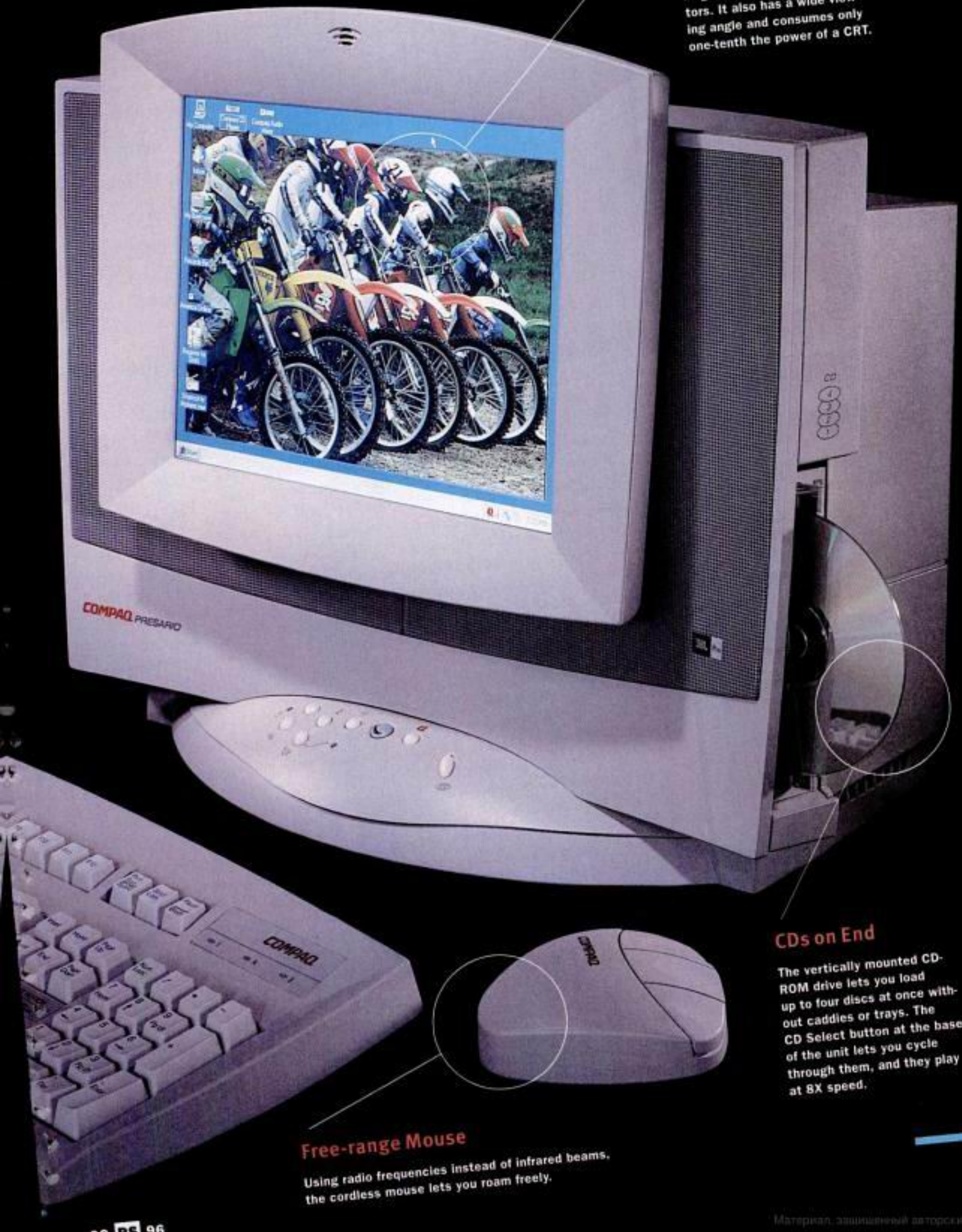
ΦPHOTOGRAPHED BY JOHN B. CARNETT



Looking Sharp

The 12.1-inch (diagonal) color LCD screen is twice as bright as a typical laptop screen, and up to 60 percent brighter than desktop monitors. It also has a wide viewing angle and consumes only one-tenth the power of a CRT.

CDs on End

The vertically mounted CD-ROM drive lets you load up to four discs at once without caddies or trays. The CD Select button at the base of the unit lets you cycle through them, and they play at 8X speed.

Free-range Mouse

Using radio frequencies instead of infrared beams, the cordless mouse lets you roam freely.

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Reinventing the Home Computer

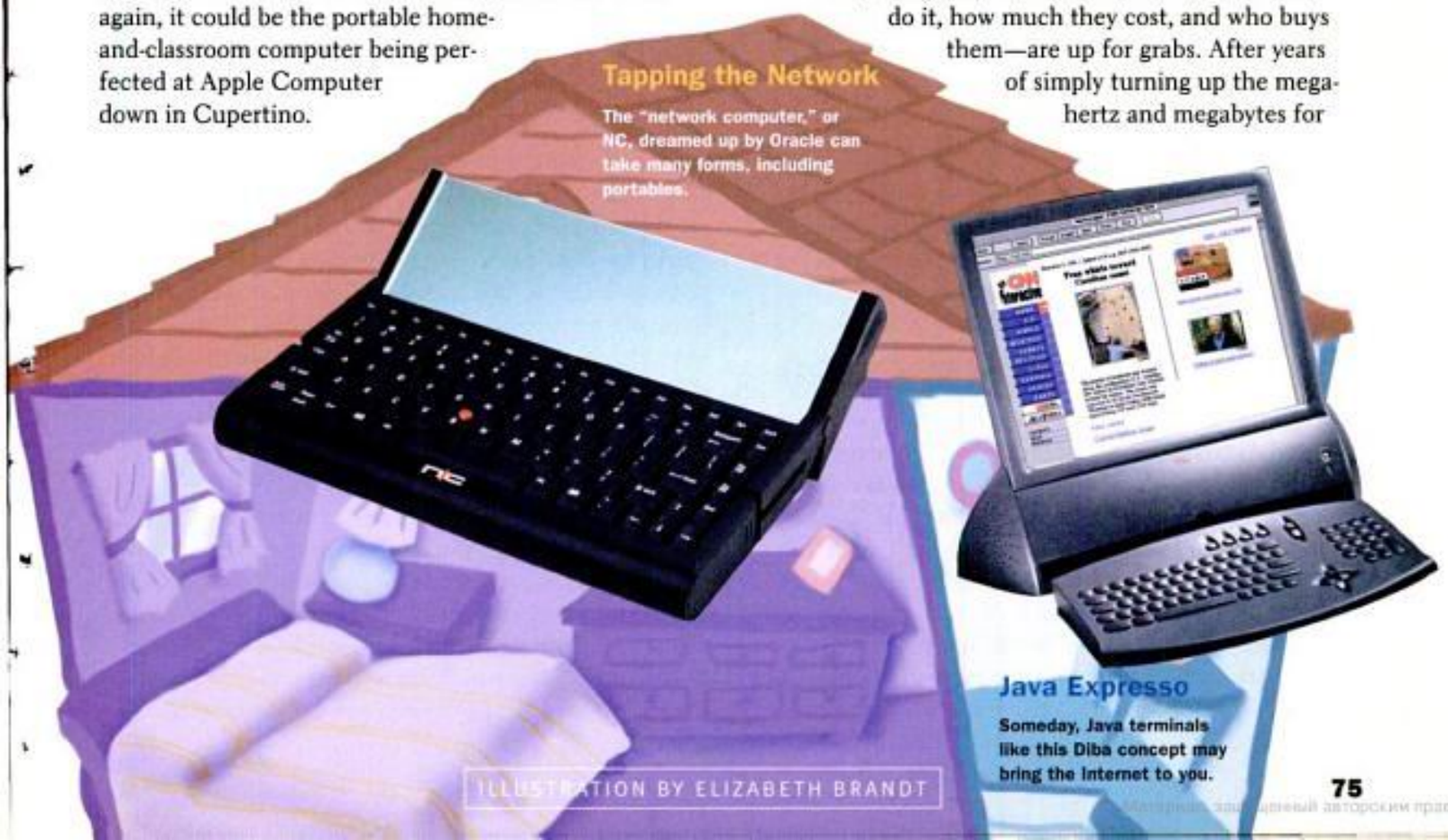
The PC is getting a makeover. But it may turn out to be a do-over.

By Chris O'Malley

WANDER THROUGH Silicon Valley, the cradle of computing that stretches from San Jose to San Francisco, and it's not hard to see the Next Big Thing in home PCs. It's something called the Network Computer, and it's inside the gleaming glass towers of Oracle Corp. in tidy Redwood Shores. Or, wait, perhaps it's one of the many "information appliances" being developed at startup Diba Inc. inside a renovated warehouse in a gritty industrial section of Menlo Park. Or maybe it's the slick Internet television system of WebTV Networks in brainy Palo Alto. Then again, it could be the portable home-and-classroom computer being perfected at Apple Computer down in Cupertino.

Even within this narrow band of occasionally shaky ground bordered by Routes 280 and 101, that's merely an abbreviated tour of the new thinking about home computers these days. There's much more: In San Jose, engineers at Sony Electronics are weaving the company's audio and video wizardry into home PCs, while designers at Acer America experiment with new shapes and colors. Meanwhile, in Santa Clara, mighty Intel is casting the home PC as a communications hub, even as nearby Hewlett-Packard bills it as an imaging center.

What's going on here? The same thing that's happening in the labs at Compaq, Gateway, IBM, Microsoft, Philips, Thomson, and countless smaller companies, here and abroad. They are reinventing the home computer, and our most basic notions about PCs—what they look like, what they do, how they do it, where they do it, how much they cost, and who buys them—are up for grabs. After years of simply turning up the megahertz and megabytes for



Tapping the Network

The "network computer," or NC, dreamed up by Oracle can take many forms, including portables.

Java Expresso

Someday, Java terminals like this Diba concept may bring the Internet to you.

ILLUSTRATION BY ELIZABETH BRANDT

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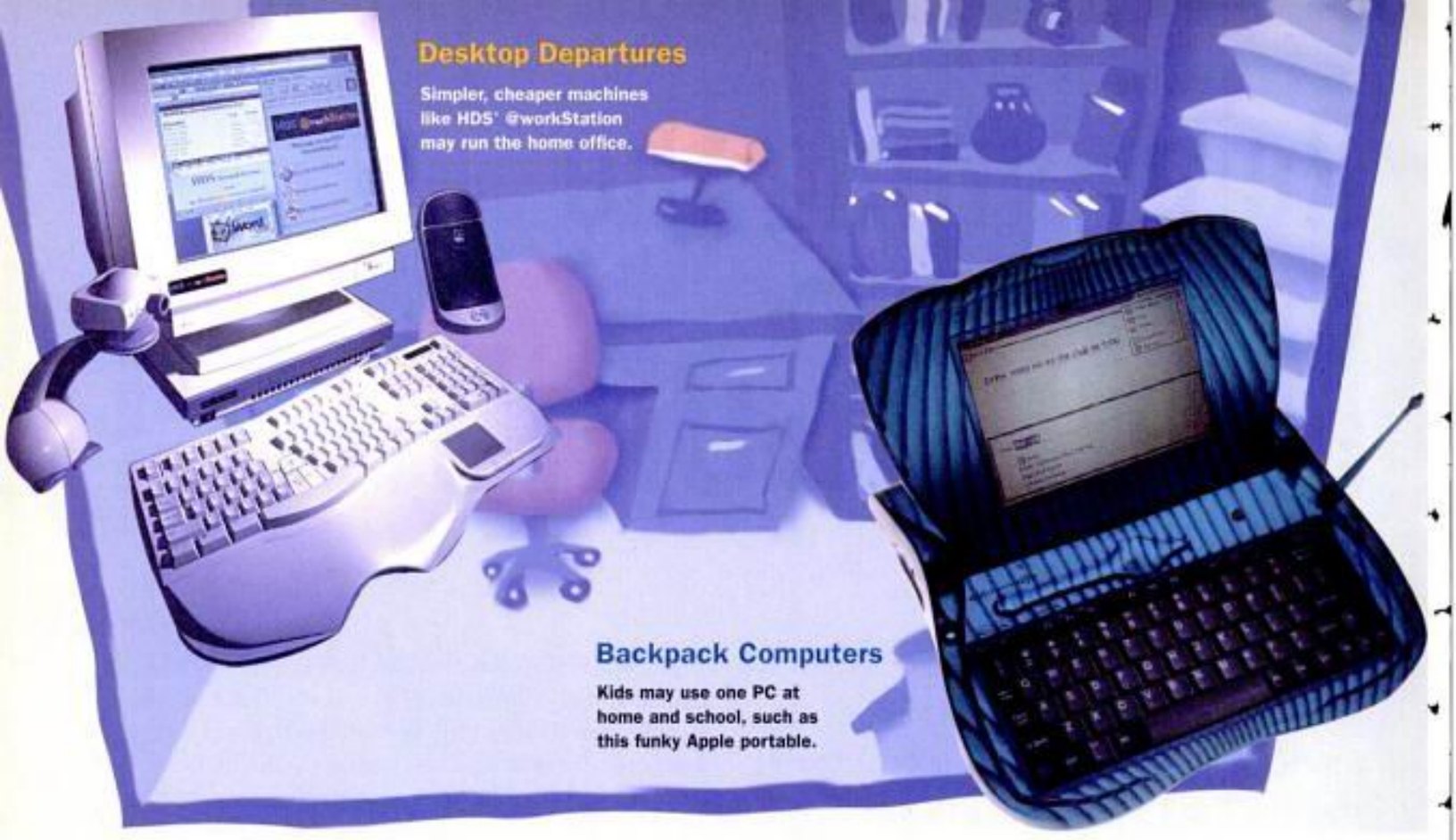

Desktop Departures

Simpler, cheaper machines like HDS' @workStation may run the home office.

Backpack Computers

Kids may use one PC at home and school, such as this funky Apple portable.

business customers and then passing the same boxes onto consumers, the computer and electronics companies of the world are endeavoring to build a home PC that can rival the telephone and television for usefulness and ubiquity.

Take your mark and get ready—the Race to Build the Great Home Computer is on. But this race has few rules and no clearly marked finish line. "The whole notion of a home computer is changing dramatically," says Andy Hertzfeld, the software wizard who helped create the original Macintosh—once touted as "the computer for the rest of us"—and who now toils at General Magic in Sunnyvale, California. "Computers in the home are going to be so diverse, and so pervasive, it'll almost be too broad a category to call them home computers."

On the surface, today's multimedia home computer might seem an odd choice for an overhaul—or an outright replacement. Computers get more versatile every year and, in time-adjusted dollars if not actual price, they are less expensive than ever. Home PCs have proven tempting enough that roughly a third of U.S. households have invested in one, and overall PC sales are still rising.

Yet, many both inside and outside the computer industry see the glass as two-thirds empty, with little prospect of filling. The "early adopters" and well-to-do families may have home PCs, they argue, but computers as we know them are still far too complex and costly for the less tolerant, less affluent masses. More intractably, many Americans still don't see the need for a PC in their homes. And many of the families who've already bought in aren't thrilled with their cranky, quickly outdated machines.

"The home PC has basically been a failure," asserts Paul Saffo, a director at the Institute for the Future, a digital think tank in Menlo Park. "It's been a sometimes useful failure, but nonetheless an artifact of office processing machines that do not present a very compelling experience for consumers." And that, he notes, is the lesson in all this for anyone who wants to bring computing home: "It's the experience, stupid."

How do you make a simpler, cheaper, stabler machine that delivers a more inviting experience? There is little consensus, but many of the disparate visions can be broadly categorized into five types of future PCs:

NETWORK COMPUTERS

Why buy a costly, complicated PC of your own when there are powerful computers outside your home that can supply the software, processing power, and storage space? That's the basic premise of the so-called Network Computer, or NC. Essentially, NCs are compact computers—some will be as small as TV set-top boxes—that rely on a link to a remote "server" computer to run everyday programs such as word processors and games, store data files, and surf the Internet. Many NCs will use the TV as the display, but they could also be coupled with a built-in screen or computer monitor.

There are several potential advantages to owning an NC rather than a PC. The most alluring may be its low cost. The NC has a central processor and some of the input-output functions of a PC, but not its large amount of memory, disk drives, or audio and video processing gear. In fact, several companies are working on putting nearly the entire set of NC functions onto a single chip. Conse-

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quently, homebound NCs are expected to cost between $300 and $700. Other pluses: There's no internal hardware to install or configure, software could be automatically updated for you, and because all files are stored on the network, you might never lose data again. Moreover, freed from Windows and Mac conventions, NC service providers and software programmers have another shot at making computers easy to use. "We know that computers are still way too complicated for many consumers," says Dan Stack, a manager in Oracle's NC division. "If PCs cost $1.50, my parents still probably wouldn't buy one."

But significant drawbacks will arise, too. Chief among them is the fact that the data pipeline into most homes—the telephone line—is a narrow one, which may result in more waiting than PC owners are accustomed to. And though cable and satellite alternatives are on the horizon, that pipeline may not change for years. There would also be as-yet-unspecified monthly service bills to pay (for server access and storage). For a while, at least, your software choices will likely be quite limited, too.

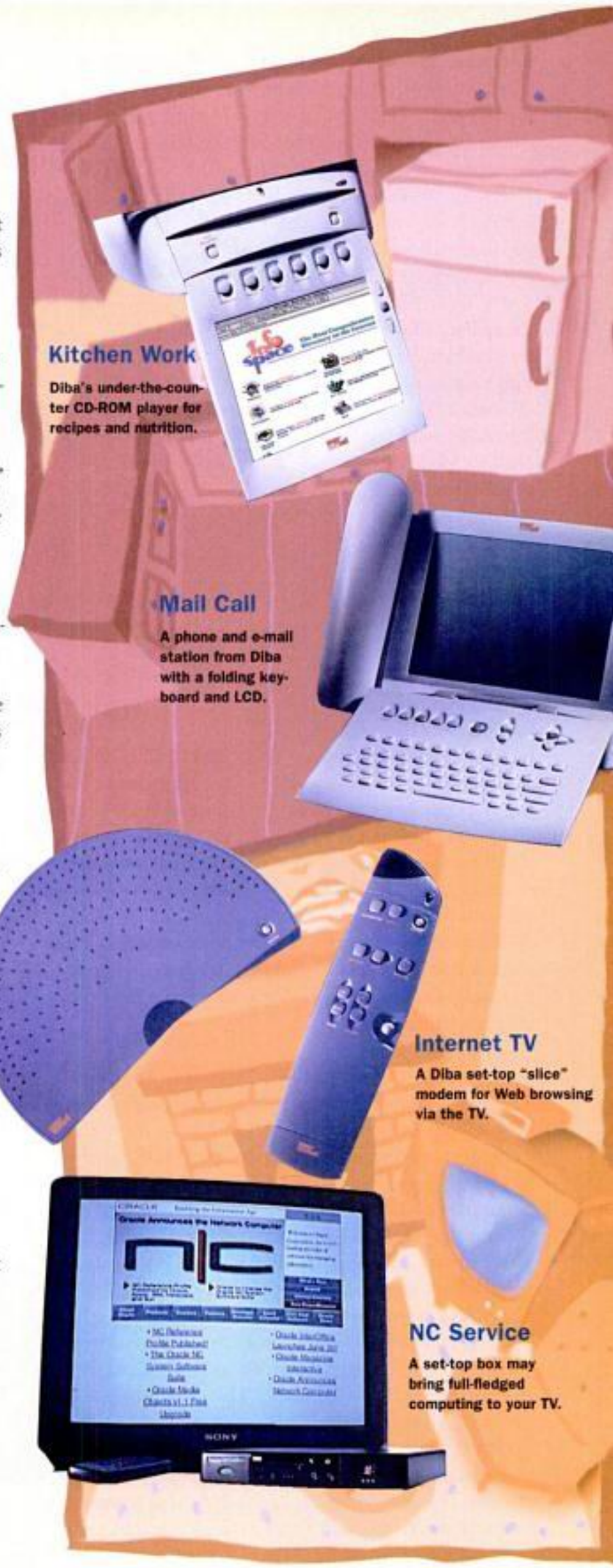
The NC concept was pioneered by Oracle, and the NC "reference profile" being used to build these systems was influenced and endorsed by Apple, IBM, Netscape, and Sun Microsystems. Several other notables, including Digital Equipment and NEC, are backing the effort as well. Oracle claims more than 60 companies are working on NC devices or services overall. The first wave of these NC-logo devices is expected to show up later this year or early in 1997.

TV COMPUTERS

Though they bear some similarity to NCs, computer-and-TV marriages—which have only recently begun tying the knot—generally do not attempt to redefine the PC or how we run software such as word processors. Rather, they fall into three subcategories that each seek to leverage the strengths of computers and TVs: Internet access devices, online game players, and full-blown PC-TV combinations.

Internet access devices, such as the set-top box from WebTV Networks that Sony and Philips (with its Magnavox brand) are selling under their own names, have a fairly narrow focus: They enable you to log onto the World Wide Web and send or receive e-mail via your TV and a phone line. [See "Web TV," October.] Most of the early devices will be in the form of set-top boxes, though Zenith Electronics and eventually others will put the circuitry inside TV sets, requiring only a phone line hookup. Though obviously limited in function, these Web browsing additions cost only $200 to $500—far less than even a basic PC with a modem.

Online game players attempt to mix the features of video games and CD-ROM discs with the appeal of the Web, again via your TV. Some in this new breed are, in fact, video game players. Sega's Saturn machine has a NetLink option for Web access, for example, and both Sony and Nintendo plan similar options for their systems.



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Get the Digital Picture

Why your next camera should be digital.

PHOTOGRAPHED BY JOHN B. CARNETT

DIGITAL photography is still new enough that most of us have yet to form an opinion about it, much less develop a point of view. But this hasn't stopped many film and computer buffs from agreeing on the early conventional wisdom about digital cameras—they're neat peripherals for your PC, but they're not suitable for everyday picture-taking.

By Chris O'Malley

The buffs are wrong: The smart money is on digital cameras—or soon will be. The latest digital cameras cost hundreds, not thousands, of dollars, and they more closely emulate the picture quality we've come to expect from film cameras. But more than anything else, digital cameras are radically redefining what photography means and what it can be.

Film and prints are not going away anytime soon. But even with improvements like the Advanced Photo System, the venerable medium of photography as we know it is beginning to seem out of step with the way we live. In our computer-and-camcorder culture, saving pictures as digital files and watching them on TV is for millions of Americans no less practical—and in many ways a lot more appealing—than fumbling with rolls of film that must be sent off to be developed.

Paper is also terribly unforgiving. Pictures that are incorrectly framed, focused, or lighted are nonetheless committed to film and ultimately processed into prints.

The digital medium changes the rules. Still images that are captured digitally (with light-sensitive semiconductors known as a charge-coupled devices, or CCDs) can immediately be shown on a computer monitor, a TV screen, or a small liquid-crystal display (LCD) built right into the camera. And since the points of light that constitute an image are saved as a series of digital bits in

Reports on the death of the personal digita assistant were apparently premature

By Suzanne Kantra Kirschner

Return of

WHEN APPLE INTRODUCED the Newton in 1992, a new product category was born: the personal digital assistant, or PDA. The promise—and the hype—seemed boundless: a computer that could organize your life, read your handwriting, and fit in your pocket. Trouble was, the early PDAs were a crude, cranky lot that didn't deliver all they promised. The Newton's unpredictable handwriting recognition quickly became more popular as a party game than as a useful tool. The early PDAs were also too big for most pockets and didn't communicate easily with the outside world. Not surprisingly, PDAs bombed.

But even with this miserable beginning, the notion of a digital helper was too good an idea to be squashed. And indeed, U.S. Robotics resurrected the PDA in 1996 with its Pilot. A sleek device only slighter larger than a deck of cards, the Pilot was small enough to slip into a suit jacket pocket without making an ugly fashion statement. More important was that, rather than attempting to fly solo, the Pilot was designed to be, well, a co-pilot of sorts, serving as an untethered adjunct to your primary computer. Your appointments, contacts, notes, to-do lists, and expenses could all be synchronized with your desktop PC by seating the Pilot in its cradle and pushing a single button. It even had a form of handwriting recognition, called Graffiti, that was fairly reliable.

Since then, a slew of PDAs have followed, including a new version of the Pilot called the Palm Pilot Pro. The Pilot now has an emulator, too, in Sharp's new SE-500. There's yet another new edition of the Newton, called the MessagePad 2000, and a new model 5 from veteran PDA manufacturer Psion.

Then there was the big shoe that dropped. Microsoft finally got around to releasing a version of its Windows operating system specifically for pocket PCs, dubbed Windows CE, and that unleashed a small torrent of entries from the likes of Casio, Compaq, Hewlett-Packard, Hitachi, NEC, and Philips. (Of this group, we evaluated the Philips Velo 1 for this report.)

Are these new-and-improved PDAs all you've been wishing for? Not likely. But they're a lot closer to the bull's-eye than when the first Newton fell from the Apple tree, and some fundamental lessons have clearly been learned.

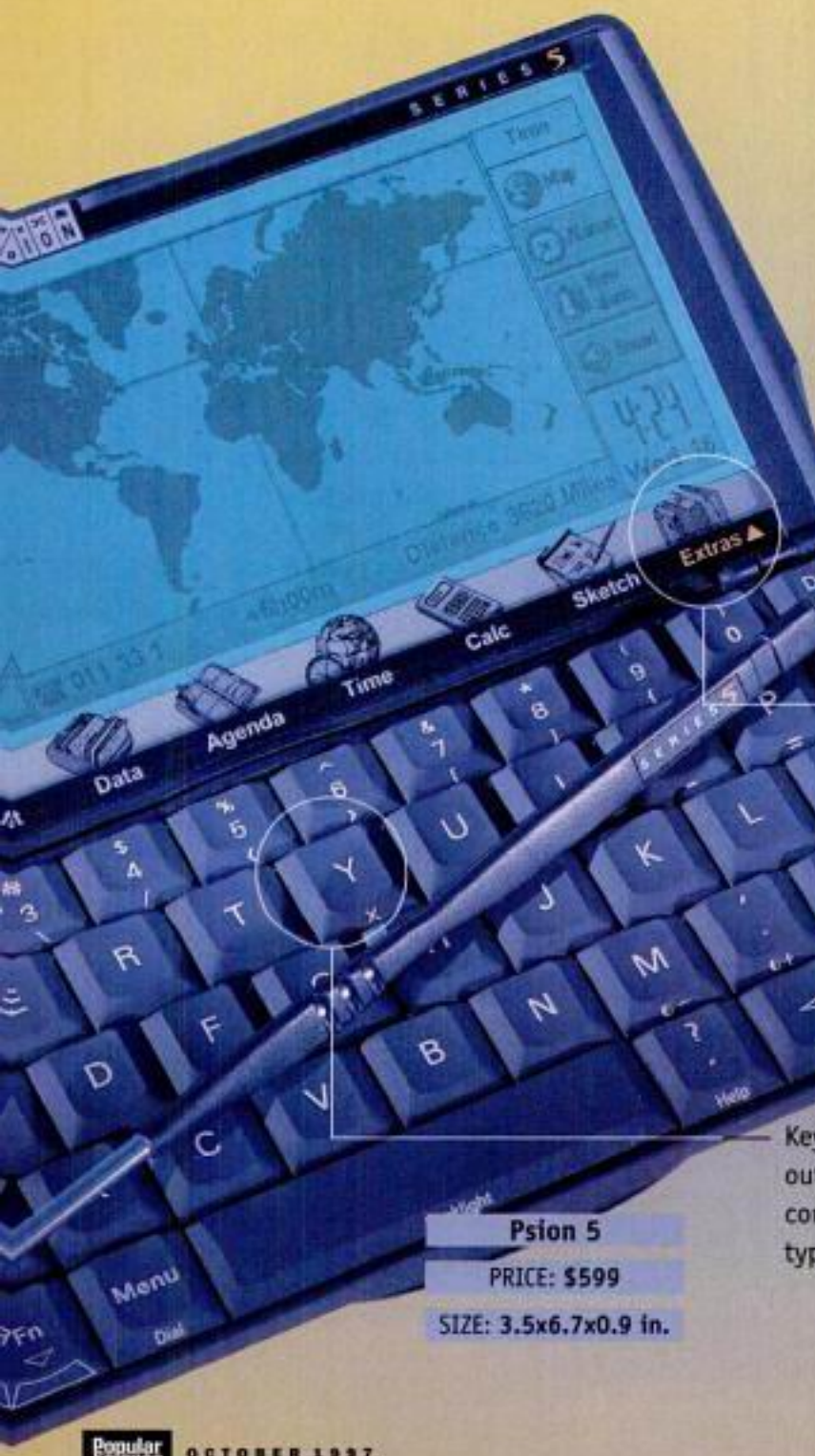
Lesson one: The human hand is not designed to enter lots of data into a small machine. The tiny keyboards and spotty handwriting recognition are just too finger-numbing for that. So nearly every PDA now can get information from desktop PCs, as well as give it.

Lesson two: PDAs are by definition portable and are used under poor lighting conditions, like the backseat of a taxi or the darkened cabin of an airplane. The new PDAs have backlit displays.

And lesson three: Communication is absolutely critical. Modems and e-mail software are now either standard built-in features or available as options on every PDA. Still, PDAs

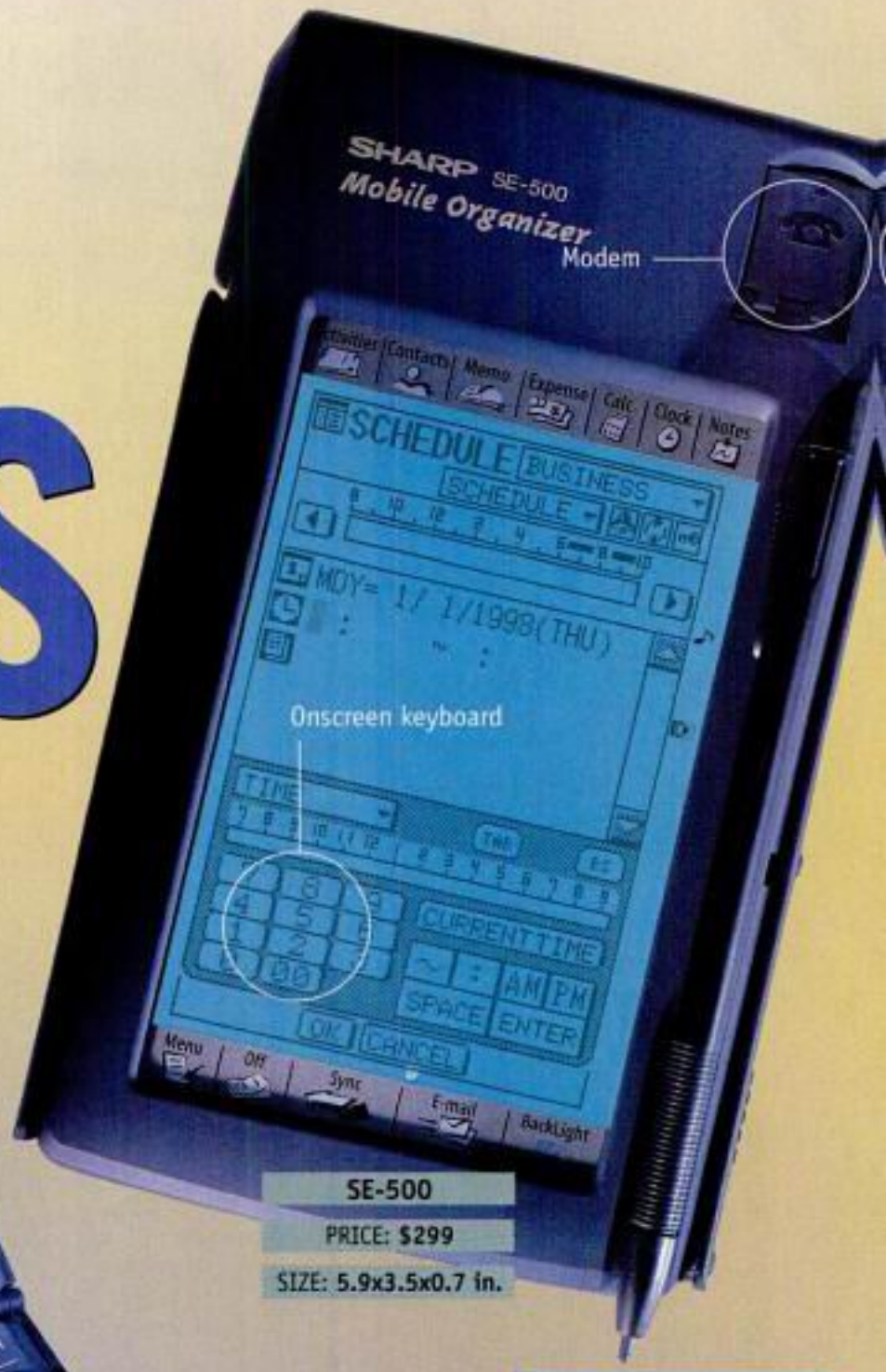
PHOTOGRAPHED BY JOHN B. CARNETT

the PDAs



One-touch program access

Keyboard slides out for more comfortable typing



You can send and receive e-mail via the SE-500's built-in 14.4Kbps modem.

Record, stop, and play buttons let you record voice memos without turning on the Psion 5.

NAME	PSION 5	MESSAGEPAD 2000	PALM PILOT PRO	SE-500	VELO 1
MANUFACTURER	Psion	Newton Inc.	U.S. Robotics	Sharp	Philips
PRICE	$599-$699	$949-$1,099	$399	$299	$699-$739
MODEM	Optional: PC Card adapter ($139) plus modem, or 14.4Kbps travel modem ($249)	Optional: PC Card modem	Optional: proprietary modem ($129)	Yes, 14.4Kbps	Yes, 19.2Kbps
PC CONNECTION	Serial cable; infrared; includes links to 2 popular organizer programs	Serial cable; infrared; includes links to 2 popular organizer programs	Desktop cradle; additional purchase for link to popular organizer programs ($69)	Desktop cradle; includes links to 3 popular organizer programs	Desktop cradle; includes links to Microsoft Schedule 7.0a
SIZE (INCHES)	3.5 by 6.7 by 0.9	8.3 by 4.7 by 1.1	4.7 by 3.2 by 0.7	5.9 by 3.5 by 0.7	3.8 by 6.8 by 1.0
WEIGHT (OUNCES)	12.5	20	5.7	6.5	14.8
SCREEN RESOLUTION	640 by 240 pixels	640 by 320 pixels	160 by 160 pixels	240 by 159 pixels	640 by 240 pixels
INPUT TYPE	Integrated keyboard	External keyboard, handwriting recognition	Onscreen keyboard, Graffiti handwriting recognition	Onscreen keyboard	Integrated keyboard
EXTRA FEATURES	External voice memo activation	Internet browser preinstalled	Large selection of 3rd party software available	Zero-touch synchronization when in cradle	External voice memo activation, Internet browser preinstalled
OPERATING SYSTEM	EPOC32	Newton 2.1 OS	Palm OS	Sharp OS	Windows CE

are far from cookie-cutter devices—or experiences.

If you're on the road often with a PDA as your portable computer, then size may matter less than a PDA's ability to collect and communicate information. The Newton MessagePad 2000, with its external keyboard and 640- by 320-pixel display, is by far the best choice if you're going to type long memos and e-mail, or work on spreadsheets. And its pair of PC Card slots enable you to use the latest modem technology while leaving room for extra storage. But you'll have to weigh that against the fact that this is a heavy and, with the separate keyboard, clumsy PDA. And chances are, you don't want to leave the keyboard.

The Newton's handwriting recognition is vastly improved, but if you got less than a B+ in penmanship, it probably won't work well enough.

In the more likely event that you're reviewing documents and responding to e-mail rather than creating lots of original material, the compromise embodied by the Velo 1 and Psion 5 may make for easier traveling. They

Browse the Internet with the Velo 1's built-in 19.2Kbps modem.

Velo 1
PRICE: $699
SIZE: 3.8x6.8x1.0 in.

The Pilot Pro's docking station provides one-button synchronization with a desktop computer.

are substantially smaller and lighter than the MessagePad and have built-in, if very small, keyboards. The Velo has a built-in modem and takes miniature flash memory cards for extra storage; the Psion has a PC Card slot for a modem or extra file space. They have reasonably equipped spreadsheet and word processing programs, and the Velo comes with an Internet browser.

You'll find typing to be a pleasant experience on neither. The Velo has a standard layout but tiny button-style keys. The Psion's keys are much larger, but keyboard layout is not the traditional qwerty style.

If you're merely looking for a way to keep track of all those brilliant ideas that only seem to pop into mind outside the office, you may not need the keyboard at all. The Psion and Velo each have a voice memo function that you can use even when they are closed up.

If you don't mind jotting things down, you can choose an even lighter traveling companion. The smaller Palm Pilot Pro uses the Graffiti handwriting recognition system rather than a keyboard. You'll have to learn the Graffiti alphabet, numbers, and punctuation, but it's a familiar, intuitive, and forgiving system. The Pilot Pro can track expenses and help you create, read, and reply to e-mail. But all e-mail is sent and received via your desktop PC unless you install additional software and buy the travel modem.

If you don't plan on inputting much of anything, but want to stay in touch, Sharp's SE-500 may be your ticket to ride. It comes with software to send and receive Internet e-mail via its built-in, if a bit pokey, 14.4Kbps modem. But entering data or responding briefly to e-mail messages can be a chore with its minuscule onscreen keyboard; canned e-mail responses are available.

The MessagePad 2000's handwriting recognition software can read cursive and printed characters.

Not sold yet? PDAs with color screens from Sharp, Casio, and others are coming later this year and next. More Pilot clones seem inevitable, too, with Microsoft reportedly working on a new PDA operating system more attuned to the Pilot's strengths. The long-awaited marriage of phones and computers may finally be consummated with new PCS voice-and-data services, too.

Who knows? With so many PDAs coming, you may yet find a pocket computer that's just your size. ◗

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Location:

E-Phones Connect

With new phones, you can check your e-mail and browse the Web without booting up.

By Suzanne Kantra Kirschner

DO YOU SEND AND RECEIVE MORE phone calls or e-mail? When you're looking for information, do you reach for the *World Book Encyclopedia* or the World Wide Web? If your answers are e-mail and the Web, or you wish they were, then a new breed of telecommunications device variously called an e-mail phone or Internet phone may soon find its way into your kitchen or living room.

What's an e-mail phone, or e-phone for short? Essentially, it's the merger of telephone and computer—or at least a tantalizing slice of what a computer provides. With most of these new screen phones, that means being able to

PHOTOGRAPHED BY JOHN B. CARNETT

PHILIPS IS-2630

PRICE: $650
E-MAIL: Any service provider
WEB ACCESS: Yes
SPECIAL FEATURE: VGA color touchscreen

read and reply to electronic mail directly from the phone, without booting up (or even owning) a PC. With some, it also means being able to scour the Web to make vacation plans or research homework assignments, albeit at slow speeds and on a rather small screen. And, oh yes, you can still make phone calls, too.

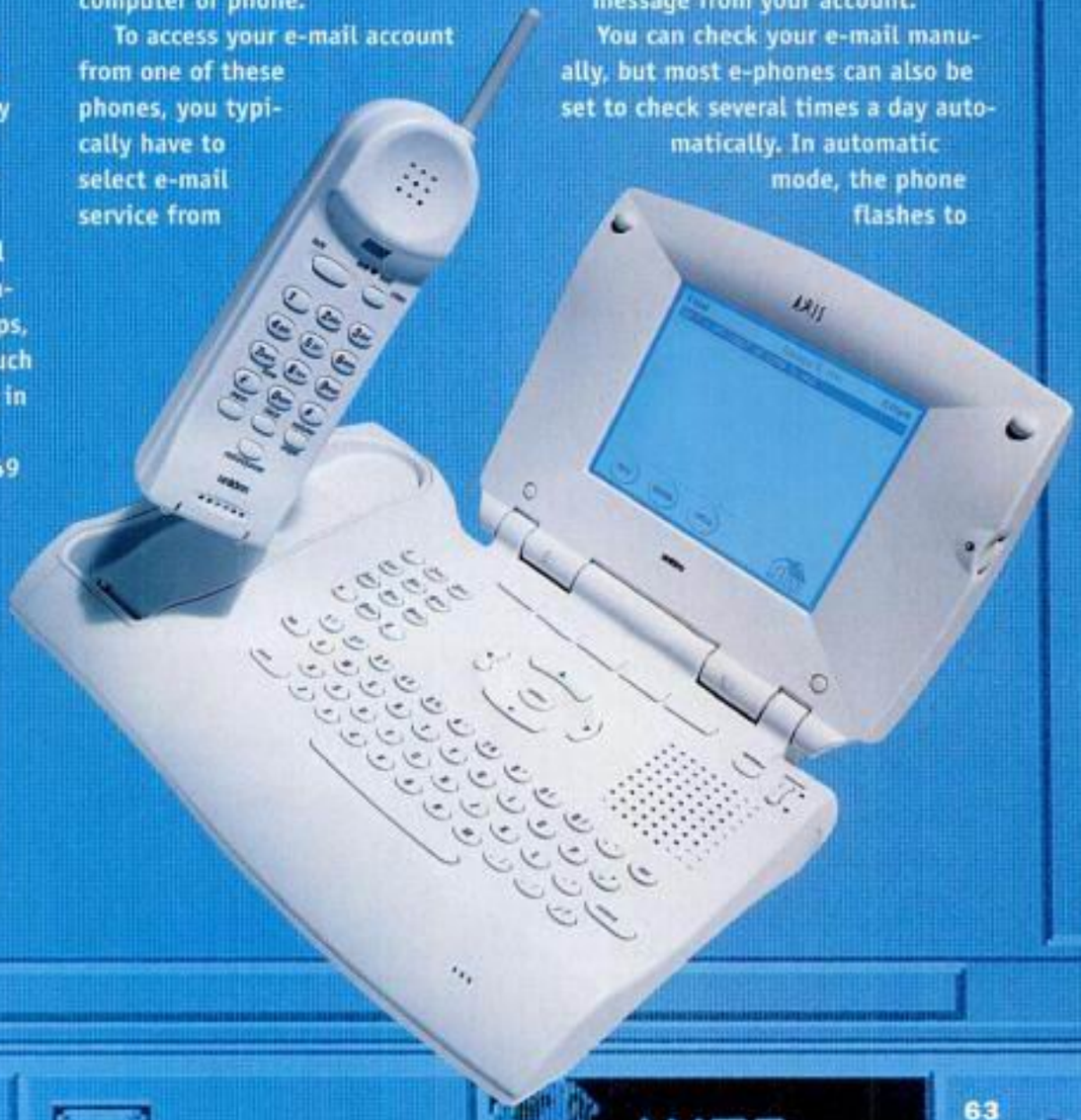
Why an e-phone? This is one invention that seems to be following our lead. Millions of us already exchange e-mail routinely with family and friends at home, not just business colleagues and customers at the office. And the kitchen or the family room is often more conducive to these personal missives than wherever the computer sits, assuming there is one. But if Internet phones serve as e-mail extension cords for the computer savvy, they also promise to get many non-wired relatives back into family circles that went electronic during the 1990s.

Though e-phones are new, you'll have more than a few choices. Alcatel, Cidco, Northern Telecom, Philips, and Uniden are each now selling such phones, or shortly will be, ranging in price from $300 to $650. Casio makes a less costly model, the $149 PhoneMate IT-380, but unlike the others, it receives only the sender's name and message subject line, not the actual message itself—for that you need a PC.

No computer experience is required to use an e-phone. Most let you sign up with your choice of Internet service provider (ISP), which typically charges about $20 per month. Some phones offer a preselected menu of ISPs, which can make getting started even easier. Ironically, it's harder to set up an Internet phone if you already have an e-mail account. You'll need to get a battery of arcane information from your current ISP, such as server authentication, domain name server (DNS) lookup addresses, and host names. Once you're past this tedious hurdle and enter this account information into the phone, you can check your e-mail from either your computer or phone.

To access your e-mail account from one of these phones, you typically have to select e-mail service from a menu. Phones with touchscreens have an icon for that on the opening screen. For other phones, you press one of the buttons lining the bottom or sides of the display, much as with an ATM machine. The phone then calls your ISP. When the ISP picks up, the phone automatically transfers your account name and password. Once accepted, the ISP will start sending the phone your messages. They appear in a list with the name of the sender, the subject of the message, and the date the message was sent. By touching the item you want to read or hitting a button next to it, the message will be displayed. Once you've read it, you can reply to the message, move on to the next one, or, with most phones, delete the message from your account.

You can check your e-mail manually, but most e-phones can also be set to check several times a day automatically. In automatic mode, the phone flashes to



UNIDEN EP 200

PRICE: $450
E-MAIL: Any service provider
WEB ACCESS: No
SPECIAL FEATURE: Cordless phone handset

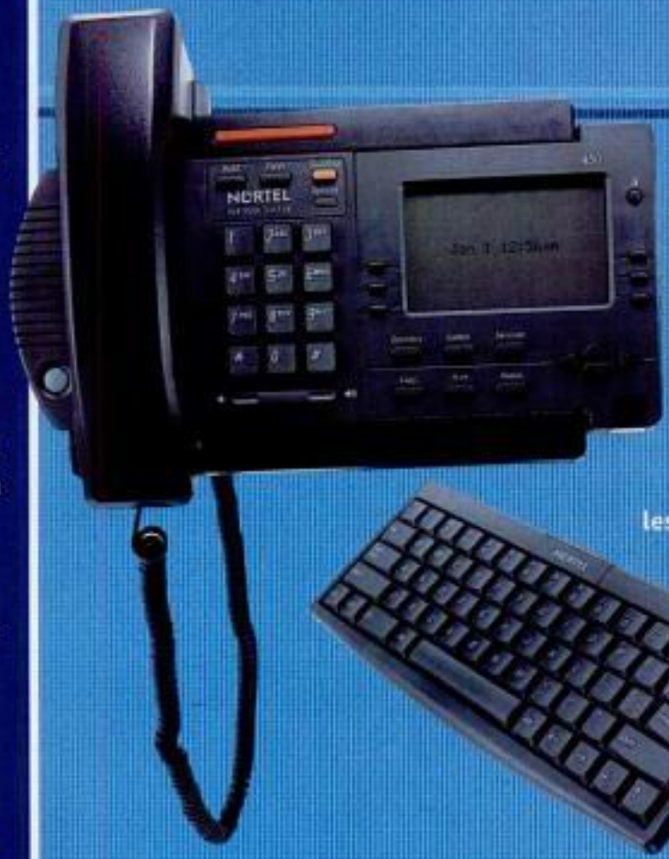
Now Brewing: Java Phones

WHILE TODAY'S Internet phones let you exchange e-mail and maybe do some Web browsing, tomorrow's promise to put an array of products and services at your fingertips, much the way France's Minitel terminals have been doing for years. And the enabling technology will be Sun Microsystem's Personal Java operating system software.

Personal Java can turn a screen phone into a device that can run computer programs, enabling you to order anything from airline tickets to a pizza, either directly or via the Internet. You might call the pizza place as usual, for example, but use a Java "applet" running on the phone's screen to check off your toppings, select a size, and hit the order button. You could even pay for the pizza with a Java smart card, a product that is already being tested.

Not all of a Java phone's added features would necessarily be about purchases. You might be able to subscribe to services that deliver wake-up calls, or remind you about impending anniversaries and birthdays. Other services, such as weather and school reports, might be more local in nature.

Alcatel's model, the 2840 (see main story), is expected to be the first Personal Java phone when it arrives this fall. There are no Java-based services for this phone to take advantage of yet, but some shopping services may be available before the end of this year. Samsung and Northern Telecom say they'll each have Java-based phones ready in early 1999.—*S.K.K.*



NORTHERN TELECOM POWERTOUCH 450

PRICE: $299
E-MAIL: SmartServe
WEB ACCESS: No
SPECIAL FEATURE: Optional wireless keyboard ($70)

less variety are by far the easiest to type on. The slide-out keyboards are considerably smaller and more cramped, and a keyboard drawer adds to the overall size of the phone. But you can't lose the keyboard, and you will never have to replace the keyboard's batteries, as you do with the wireless models.

tell you mail is waiting. If you happen to be using the phone when it is scheduled to check for e-mail, the phone will automatically try again when the line is free.

E-mail by any means can be habit-forming, so it's worth paying close attention to your keyboard options with these phones. The Philips IS-2630 and Northern Telecom Powertouch 450 phones have full-size, wireless keyboards that can be stashed elsewhere when not in use. The others have keyboards built into their units, or tucked away in a slide-out drawer. The wire-

One serious drawback to e-mail by phone is that none of these models can receive (or send) attached files, whether they contain documents or graphics. And since swapping pictures of the kids or grandkids via e-mail appendages has become one of the more appealing aspects of electronic messaging, that's a real loss. Some phones will attempt to display simple text files as part of the message, but other types of files will appear as gibberish, or not at all. If you share the e-mail account with a PC and don't delete the message, however, you can usually retrieve the message and file on your computer.

Screen size matters, too, especially

CASIO PHONEMATE IT-380

PRICE: $149
E-MAIL: Any service provider (sender name and subject only)
WEB ACCESS: No
SPECIAL FEATURE: Answering machine

CIDCO iPHONE

PRICE: $500
E-MAIL: Any service provider
WEB ACCESS: Yes
SPECIAL FEATURE: VGA black-and-white touchscreen

on e-phones designed to cruise the Web as well as park your e-mail. The Northern Telecom and the Uniden phones, for example, which give you access to e-mail but not the Web, have small, two-tone backlit displays, measuring about 3.5-inches square. By contrast, the Alcatel, Cidco, and Philips phones have displays about twice that size and are touchscreens. Cidco uses a high-resolution (640 by 480 pixels) black-and-white display. The Alcatel and Philips displays are the same resolution, but in color.

Starting a Web browsing session is similar to retrieving your e-mail. You touch a button or screen icon and the phone dials your ISP. Once connected, the default page (often a Web search page like Yahoo or Excite) is displayed. The quality of the graphics is surprisingly good on these phones, but the images are not as big or as sharp as on desktop PCs.

And the Web browsers built into these phones are more limited than on their PC counterparts. Often, the software doesn't recognize some formatting codes, so pictures can pop up in odd locations. Many helper programs—such as Java, RealVideo, and Shockwave—that add video, audio, or animation to Web pages are not available, either. But for retrieving basic information, checking stock quotes, and so on, the phones are adequate Web surfers.

They are not especially fast surfers, however. The modems integrated into these phones are usually 28.8- or 33.6Kbps models, and you can't trade up later to a higher-speed modem, as you can with PCs. They are up-to-date in most phone features: Most support caller ID, call waiting, and call logging. The Cidco, Philips, and Uniden models have calendars and phone directories as well. Only the Casio model has a built-in answering machine, but most support voice mail notification if you subscribe to your local phone company's voice mail service.

More phones are on the way. Early next year, Samsung and others expect to sell Java-based e-phones that will offer even more features and services (see "Now Brewing: Java Phones"). In particular, electronic banking and shopping services are expected to be a part of that expanded menu of options.

Are e-phones really ready for the kitchen? Maybe. Certainly, many of these models cost more than we're used to spending on phones, and they offer something less than the kind of full e-mail and Web browsing capabilities we're used to with computers. But the notion of a universal message center has at least been spawned into the real world, and the kitchen may never quite be the same again. ▶

ALCATEL 2840

PRICE: Not yet set
E-MAIL: Any service provider
WEB ACCESS: Yes
SPECIAL FEATURE: Smart card reader

Your Brilliant Assistant

Now, palm-size computers deliver a rainbow of colors with high contrast that's easy on your eyes.

By Suzanne Kantra Kirschner

CASIO CASSIOPEIA E-100

PRICE: **$499**
SCREEN TYPE: **65,536-color active matrix LCD**
BATTERY TYPE: **Lithium ion**
BATTERY LIFE: **Approximately 6 to 8 hours**
PROCESSOR TYPE: **131MHz RISC**
WEIGHT: **10.5 ounces with battery**
MODEM: **56Kbps (not yet available)**

COMPAQ AERO 2100

PRICE: **$499**
SCREEN TYPE: **256-color high reflective LCD**
BATTERY TYPE: **Lithium ion**
BATTERY LIFE: **Approximately 10 hours**
PROCESSOR TYPE: **80MHz RISC**
WEIGHT: **10.9 ounces with battery**
MODEM: **56Kbps (not yet available)**

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PHILIPS NINO 500

PRICE: **$499**
SCREEN TYPE: **256-color transmissive LCD**
BATTERY TYPE: **Nickel-metal hydride or two AA**
BATTERY LIFE: **8 hours**
PROCESSOR TYPE: **92MHz RISC**
WEIGHT: **8.0 ounces with battery**
MODEM: **14.4Kbps ($90)**

HEWLETT-PACKARD JORNADA 420

PRICE: **$519**
SCREEN TYPE: **256-color passive matrix display**
BATTERY TYPE: **Lithium ion**
BATTERY LIFE: **6 hours**
PROCESSOR: **100MHz RISC**
WEIGHT: **8.8 ounces with battery**
MODEM (THIRD PARTY): **Pretec Electronics CompactModem, 56Kbps ($170)**

BLACK 7 ON GRAY 8. Gray jack on black queen. Playing solitaire on the screen of a handheld PC leaves something to be desired—namely, color. But until recently, color wasn't even an option on these pint-size PCs. Now, you have your pick of color handhelds with the introduction of Casio's Cassiopeia E-100, Compaq's Aero 2100, Hewlett-Packard's Jornada 420, and Philips' Nino 500, all based on the Windows CE platform.

OK, solitaire may not be the most productive example of color's appeal. Some of the perks are admittedly hard to quantify. But this much is certain: Color gives you a clearer view of what's on these tiny screens, and adds a comforting Windows feel (assuming you do Windows) to these Windows CE gadgets, with familiar icons that more vividly pop out at you. To the extent that your CE companion is a complement to your desktop or laptop, that puts your world a bit more in sync. And there are some concrete advantages to color too. You can view images attached to e-mail messages, for example, or do some limited Web browsing in color. (All come with browser software, though modems are optional.)

When you get right down to it, though, most of your time is spent peering into the screens of these palmy assistants, trying to read appointment schedules or phone numbers. And that's where the benefit of color comes into stark relief—literally. The grayscale displays used on previous models simply don't have the contrast that the color displays have. So while the resolution of the text may be the same, it's easier to read on the color displays because you're seeing black text on a white background rather than dark gray text on a light grayish-green background. Palm Pilot maker 3Com Corp. recognizes the problem too, and while its latest product, the Palm V, still has a monochrome display, the contrast is vastly improved (see "What About a Color Palm?").

What price color? Aside from the

PHOTOGRAPHED BY JOHN B. CARNETT

What About a Color Palm?

PALM PILOT OWNERS can be forgiven for a little color envy. While many of the Windows CE handhelds are adding color displays, the Palm remains stubbornly monochrome. Future Palm products may have color displays, says 3Com, but the company won't say exactly when. Industry rumor has it that a color model, code-named Raptor, might be out as early as the end of this year.

In the meantime, 3Com is not resting on its well-earned laurels. The most recent additions to the Palm family, the Palm V and Palm VII (the company decided to skip the even numbers), have higher-resolution displays with better contrast, and address a few key battery life and communications problems.

With the Palm V ($449), you may never have to worry about changing or charging your battery again. Its built-in lithium ion battery will run for 30 days without needing a recharge. But you need not even think about recharging if you keep the Palm V in its synchronization cradle, which has a battery charger built in. Every time you swap data with your desktop PC, the battery is topped off. The Palm V is also nearly half the thickness, at 0.45 inches, and a full 2 ounces lighter than the Palm III, which weighs 6 ounces. The Palm V nonetheless retains all of the Palm III capabilities. It has the same 2MB of storage, wireless infrared transmitter, and software as the Palm III, which includes an expense tracker, games, e-mail, address book, and calendar.

It may be monochrome, but the Palm V is slimmer than its color counterparts.

The Palm VII (less than $800) also has the Palm III's features, but adds a built-in two-way radio for wireless access to e-mail. You can forward messages from your current e-mail account while you're on the road, or people can send messages directly to your Palm VII account. And you can send e-mail to any Internet e-mail address. To retrieve messages, you just raise the antenna and the unit downloads them from the nationwide wireless radio network. Such freedom brings a monthly service charge, of course, which starts at $10.—*S.K.K.*

$500 purchase price of these gadgets, you'll pay for a superior screen with abbreviated battery life. These devices last for a mere 6 to 10 hours of continuous use on a charge (or in the case of the Nino, on a pair of alkalines). Compare that with the 30 *days* you'll get with a Palm V.

As laptop PC users know, not all color screens are created equal. Each of these palm-size PCs uses a different screen technology. The Cassiopeia's active matrix (or TFT) LCD is by far the best display. This technology, the same used in better laptops, is the brightest, and it displays thousands of colors rather than the hundreds the others do. The extra colors translate into more accurate skin tones and finer color gradations in pictures. The Casio has a standard CompactFlash slot for adding more memory or a modem but offers few extra programs or perks.

Aero's 256-color reflective active matrix LCD uses ambient light to generate color rather than powering each pixel to glow as the Cassiopeia does. It offers a crisp display under bright lights, but lacks color clarity in low-light conditions even with its front light turned on. It still packs lots of useful goodies, however. It has a shielded CompactFlash slot so it can also accept pager cards without the threat of RF interference, plus a vibration alarm for appointment reminders. A robust software bundle includes a program for playing audio content downloaded from the Web, a flight scheduler, an image file viewer, and an English to Spanish or Japanese dictionary.

The passive matrix LCDs of the Nino and Jornada are not quite as bright as the Cassiopeia's screen, but they're actually brighter than the Aero's reflective display. Passive displays, used in some low-cost laptops, distribute light by row, rather than the active-panel approach of delivering it to each pixel. This method of back lighting saves power, and the Nino is the only color model that can run on rechargeable or alkaline batteries. The Nino and Jornada are about 2 ounces lighter than the active matrix models too, which is more noticeable than it may sound in pocket-size devices. Both also come with audio player and image viewer software, as well as a CompactFlash slot (with the Jornada's being shielded for pager cards). The Jornada has another nice touch: a transparent cover, which folds back when you're using the device.

What's notably absent from all of these palm-size PCs is a built-in modem. Philips, Casio, and Compaq will offer modems as an option. Third parties already sell modem cards and will soon have pager cards as well.

Why pay the premium for a colorized companion? Better visibility is certainly the main reason, and that's no small matter in a gadget you depend on to organize your life. But color is at least as much visceral as it is functional here. Still, if it gets you to the meeting on time, it might just color your world a happier place.

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Power Phones

What do you get when you merge a cellphone and a personal organizer? One pretty smart phone.

By Suzanne Kantra Kirschner

QUALCOMM PDQ	
PRICE	$500 to $1,000, depending on service
SIZE	6.2 by 2.6 by 1.4 inches
WEIGHT	10 ounces
SCREEN SIZE	1.9 by 2.4 inches

PHOTOGRAPHED BY JOHN B. CARNETT

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ON A RAINY DAY in New York City, I can be 10 to 15 minutes late to an appointment without feeling too much guilt about not calling ahead. But sitting in a cab that's crawling along Park Avenue more slowly than I can walk, I finally had to concede I wouldn't make it to my destination within even my generous lateness guidelines. It was time to make the familiar "I'm running late" phone call, and check to see if the delay will have a domino effect on my schedule.

Ordinarily, that involves yanking two devices from my bag: my cellular phone (to make the call) and my personal organizer (to check my schedule and perhaps get the phone number I need). This time, however, I could do it all with one gizmo: my new smart phone, which combines a wireless phone with an electronic organizer à la 3Com's Palm or Franklin's Rex. It's the next best thing to having a human assistant at your side.

Smart phones aren't new, at least in concept. BellSouth merged cellular phone and handheld computer functions in its Simon, an innovative but bulky device that never caught on. Nokia's 9000, a phone that opened clamshell-style to reveal a keyboard and screen inside, was a considerably sleeker attempt to combine communication and organization, but it wasn't received very well either—at least in the United States—in part because it used the European GSM wireless standard. (It got a warmer reception in Europe and even spawned a second generation, the Nokia 9110, last year.)

But even without a hit product, the idea makes too much sense simply to pass quietly into the conceptual mist. Now, two of the biggest names in cellular phones, Motorola and Qualcomm, are each taking a stab at wedding the engaged worlds of phone calls and personal info. Qualcomm's pdQ has an organizer built into the phone. Motorola's StarTac Mobile Organizer piggybacks atop a StarTac phone.

At first glance, the pdQ looks a bit like a mobile phone on steroids. And at 10 ounces, it's about twice as heavy as some of the smaller wireless phones these days. But there's a lot going on inside. The keypad flips down to reveal a spacious (for a phone anyway) LCD screen, with icons that will be familiar to anyone who's used one of 3Com's Palm devices. Indeed, that's

MOTOROLA STARTAC MOBILE ORGANIZER	
PRICE	$250
SIZE	4.1 by 1.9 by 0.9 inches
WEIGHT	2.3 ounces (under 6 ounces with phone)
SCREEN SIZE	1.3 by 2.2 inches

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What's New

GENTLEMEN, START YOUR DROOLING

REINVENTING TIME FOR THE WELL-HEELED MOTORHEAD.

FRONT

Tag Heuer has always ruled the racetrack—from its Carrera chronograph in the 1960s to last year's SLR, designed to resemble the Mercedes-Benz supercar of the same name. But never before has the Swiss watchmaker gone so far as with the Monaco V4, which reaches under the hood to take inspiration—both aesthetic and technological—from the internal combustion engine. Unveiled as a prototype this past April in Basel and not yet scheduled for release, the V4 is the first wristwatch ever to run on drive belts.

Automatic watches ordinarily use dozens of gears to power movement, but belts are more efficient because they cut out the friction inherent in a chain of cogs.

The V4, which took 20 months to develop, uses 13 half-millimeter-wide synthetic belts. They drive metal wheels that rotate on low-friction microball races rather than the synthetic

TAG, YOU'RE IT: **The first watch to use drive belts to power movement.**

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BACK

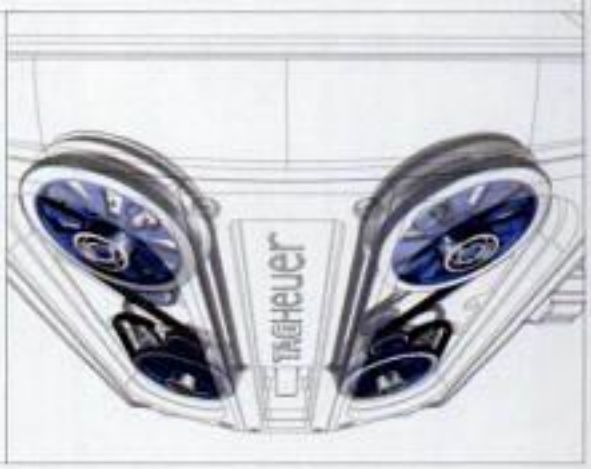
WATCH THE REVOLUTION: **Three panels of synthetic sapphire provide a peek under the hood of this chronometer.**

ruby pivots known as jewels. The movement is powered by a platinum ingot that shuttles back and forth to turn a cog as you move your wrist. The drive belts transfer that torque to four spring-loaded barrels, which run a balance wheel (more belts) that ticks off the hours, minutes and seconds indicated by the watch's hands.

While none of these changes are exactly necessary, the V4 falls into a long and illustrious line of watchmaking innovation, otherwise known as showing off. Critics point out that a weight limited to moving along one axis can capture only a fraction of the energy that one free to pivot 360 degrees can. What they're ignoring is the watch's aesthetic—and the audacity of its design. The V4 won't set watchmaking on its head in the way ultra-accurate, low-cost quartz movements did in the early 1970s, but it may be the biggest innovation since then. Either way, it'll cost you between $6,000 and $12,000.—JONATHON KEATS

THE ENGINE
A 4.25-gram platinum ingot slides back and forth in a central channel at the back of the watch, capturing power from the wearer's wrist movements. The ingot is machined with teeth along one edge that engage a cog at the side of the channel, rotating it with each pass.

THE TRANSMISSION
Four synchronized barrels, each containing a metal spring, store enough energy to run the V4 for 50 hours even when you're not wearing it. The barrels turn the movement using 13 0.5mm-wide belts tightened with minuscule turnbuckles to a tension far beyond what jeweled pinions could sustain.



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SONY
WATCHMAN
TOSHIBA

You'll never miss a ball game with go-anywhere TV

Small-screen sets, diminutive in size and versatile in power requirements, let you take your show on the road

By V. ELAINE SMAY
PHOTO BY GREG SHARKO

What do you do when:

- It's time for the opening kickoff of the Superbowl and you're stuck in traffic?
- You're two-thirds through "Gone with the Wind" and the power goes off?
- You want to use your new Timex Sinclair portable computer [PS, Aug.] on a business trip, but you need a television set to serve as a display?

Answer: You reach for your portable TV. And I don't mean some 40-pound colossus that happens to have a handle on top. Today you can get a TV that's almost as easy to take along as a tape recorder. Smallest to date, Sony's monochrome Watchman (see photo) will slip into a roomy pocket or ride in a briefcase—with lots of room to spare. Probably the smallest color set, Panasonic's CT-3311 (not available when we took our picture) has a 2.6-inch screen and a cabinet about the size of a child's shoe box.

If you're willing to sacrifice some compactness, you can get a unit that includes a radio, tape recorder, and perhaps a clock along with the TV. One even includes a micro video cassette recorder.

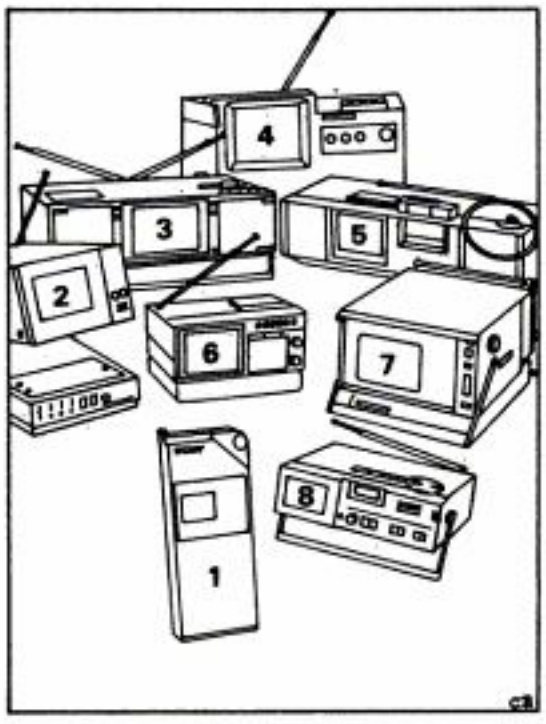
These little TV's can get their power from a variety of sources. Most can run on either line current, batteries (dry cells or rechargeables), or a car battery.

Flattening the screen

Sony's Watchman is the first TV on the market with a flat display. Like the others, it uses an electron-gun phosphor-screen cathode-ray tube (CRT). But Sony has put the electron gun below the phosphor screen and parallel to it (rather than behind and perpendicular to it), forming a paddle-shaped CRT that's only ⅝ inch thick.

Sinclair Research Ltd. is about to bring out its own monochrome TV with a flat CRT [PS, June '81]. It will include an FM radio and sell for less than $100.

Seiko, the Japanese watch company, has taken another route to flat-screen TV. Due on the market soon is its wristwatch TV with a liquid-crystal screen [see "What's New," this issue]. Sorry about that, Dick Tracy.



1) Sony FD-210, the Watchman, a monochrome TV with two-inch screen, measures eight by 3½ by 1¼ inches, weighs just over a pound. Price: $350. **2) Sony's Trinitron** color TV, the KV-4100, has a 3.7-inch screen. Push a button and the TV section lifts to reveal an AM/FM radio and microcassette recorder (with memory). Input-output jacks allow hookup to VCR or video camera. Price: $880. **3) JVC CX-710** has a five-inch color TV, AM/FM stereo radio, stereo cassette-tape recorder, jacks for external speakers, mikes, headphones. Size: 16 by 11½ by 4½ inches. Price: $720. **4) Technicolor Video Showcase** combines a 7½-inch color TV with a portable microvideo cassette recorder (¼-inch tapes). You can shoot with any video camera and have instant replay. It weighs 24 pounds, measures 18½ by 12¾ by 7¾, costs $1,795, with rechargeable battery. **5) General Electric's Road Show** features a four-inch color TV, AM/FM stereo radio, a detachable stereo microcassette-tape recorder, and stereo headphones. Price of the model 4CM3326X: around $700. **6) Panasonic's Outsider** line includes this four-inch monochrome TV, model TR-4030P, with electronic push-button tuning. Detachable battery case (shown under set), with 10 D cells, adds about five pounds to the basic three-pound weight, and is included in the $200 price. **7) Toshiba's CA-045** color TV has a 4½-inch screen, pull-out sunshade, jacks for VCR or video camera. Size: 10½ by 7¾ by 4⅝; price: $500. Optional battery case (under set) takes nine D cells or rechargeable nicad. **8) Sanyo TPM 1100** is a monochrome two-inch TV, AM/FM radio, LCD quartz alarm clock. The set comes with a vinyl carrying case and shoulder strap. Detachable hood for TV improves outdoor viewing; magnifying lens is optional. Size: 6⅞ by 6¼ by 2½; weight: about three pounds (with six AA cells). Price: $250.

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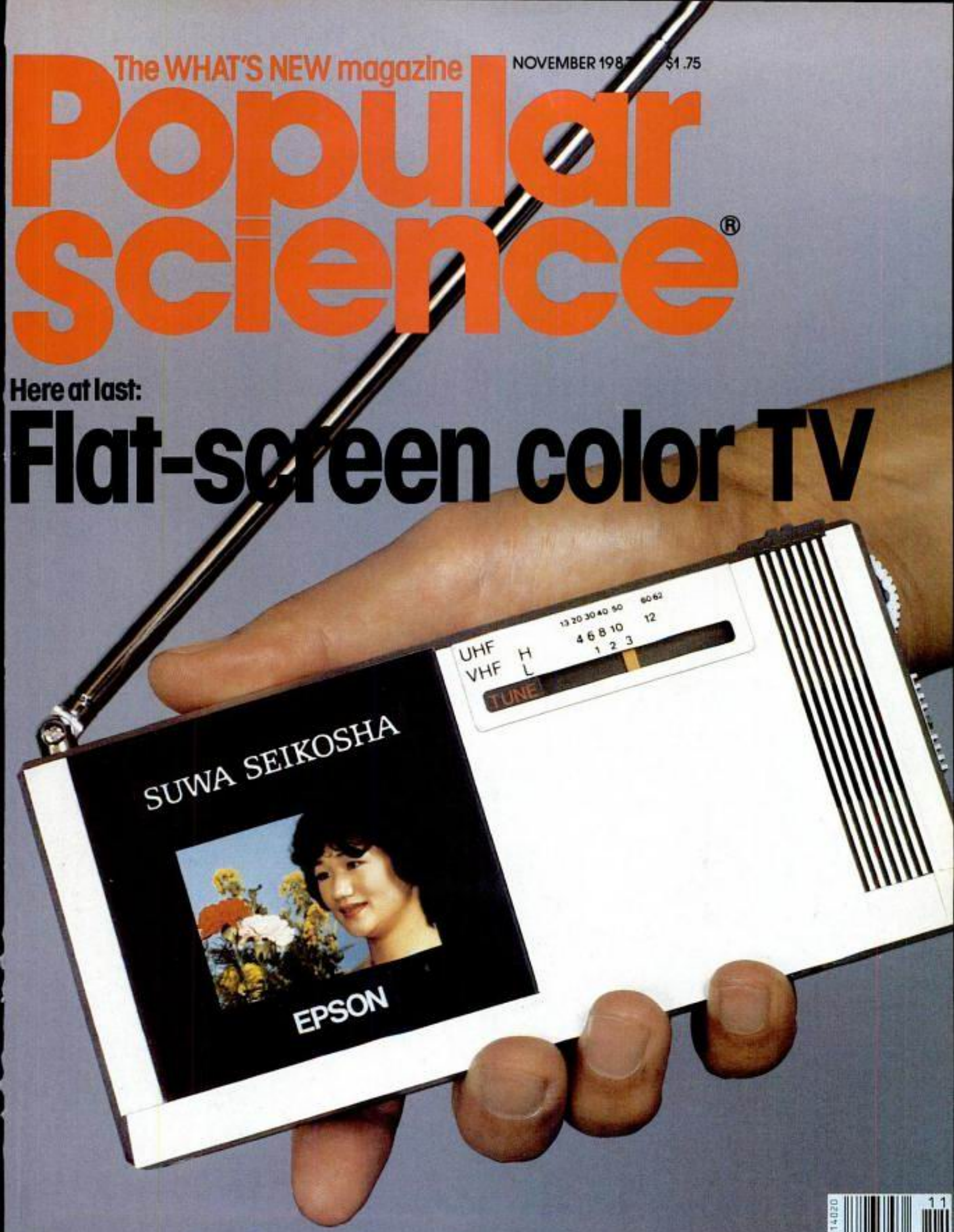
The WHAT'S NEW magazine

Popular Science®

NOVEMBER 198[illegible] $1.75

Here at last:

Flat-screen color TV



Spy photos from space

0 14020 11 726597

Hand-size, but here at last:

flat-screen color TV

Pocket-size TV sets using a flat screen and liquid-crystal displays are already in the stores. But they have monochrome (single-color) displays. Now, breakthroughs by a team of Seiko engineers in liquid-crystal chemistry and transistor design are finally going to bring flat-screen *color* TV to the marketplace. The Japanese engineers have created new fast-response liquid crystals and thin-film transistors that overcome the major problems of LCD color TV. The Seiko Pocket Color TV should be on the market in about six months. A PS editor visited Seiko's research and development headquarters in Suwa, Japan. He found picture quality highly satisfactory. Although the colors were not as crisp as the very best produced by cathode-ray tubes, they were bright in daylight, and resolution was sharp and clear.

By HERBERT SHULDINER

SUWA, JAPAN

The image was clear and the colors were bright as I watched a baseball game on the tiny screen of a TV set small enough to slip into my jacket pocket. But the fact that the athletes were Japanese wasn't the only thing different about this TV picture. I was viewing the world's first flat-screen liquid-crystal color television announced for sale.

LCDs aren't new, of course. Many of us have calculators or watches with the displays. And black-and-white LCD TV sets are already on the market, including a tiny wristwatch TV [PS, April]. So why all the excitement about this new system? And why have a handful of Japanese companies, including Hitachi, Matsushita (Panasonic), Seiko, and Toshiba been in a race to be first to market this type of TV? Each one of the companies has demonstrated prototypes at electronics trade shows. In addition, Mitsubishi has exhibited a large-screen LCD color TV designed for industrial displays. Now Seiko has announced plans to market the first consumer LCD color TV. It will be on the market in about six months.

The Seiko TV is a prodigious engineering achievement. A color LCD TV is much more difficult to make than a black-and-white one. The Seiko Pocket Color TV required the use of a new type of liquid crystal, which responds twice as fast as conventional LCs, and virtually invisible thin-film field-effect transistors. The use of thin-film transistors had been limited to exotic flat-screen displays made for the military.

I visited the Seiko research and development center in Suwa to preview the new color-TV system. I also interviewed the three engineers who headed a 20-man research team that developed the system over a period of approximately five years.

"The principle is very simple," Toshiaki Saito, director of Seiko's research and development division, told me as he held the 1.1-pound TV set in his hand. "The system is much the same as that used in an LCD watch," he continued. "Liquid crystals are sandwiched between two panels of glass. When the LC spots are excited by a voltage, the spots turn black, just as they do in an electronic watch."

But there are significant differences between a watch and the color-TV set, Saito says. Besides the new LCs and thin-film transistors, a color filter is used to create an entire spectrum of hues for the TV image.

Twisted crystals

The new liquid crystals used in the Pocket TV resulted, Saito says, from organic-chemistry research carried on by Seiko. But he refused to specify how they differ chemically. "We use twisted-nematic-mode LCs [see drawing on last page of article] because they have high contrast and low power consumption, and they respond in less than half the time of conventional LCs—less than 50 milliseconds compared with about 100 milliseconds." The rodlike, twisted-nematic-mode LCs are used in virtually all calculator and electronic watch displays made today.

Shinji Morozumi, manager of Seiko's research and development department, explained why LC response speed is critical in a TV set: "When you see a baseball game on a screen made of conventional liquid crystals, the image flows. A thrown or batted ball looks like a comet." There was no indication of this, however, as I watched the videotaped ball game on the Pocket TV screen. I could see the ball clearly, and when players ran they could be seen distinctly, without any blurring. To make sure this wasn't due to the fact that I was watching a specially selected tape, I asked Morozumi to tune in a real-time broadcast. He immediately disconnected the VCR cable and extended the set's telescoping antenna. He handed me the little TV, and I tuned in a Japanese soap opera. The colors were still bright, and moving images remained stable. There was no blurring whatever.

The LCs in the Seiko Pocket TV are encased in a 43.2-mm-by-34.2-mm (1.7-by-1.3-in.) glass-sandwich panel (see illustration on opposite page), which is divided into 57,600 pixels, or picture elements. Driving each pixel, Morozumi explains, is a matching thin-film transistor. The transistors, made in a Seiko integrated-circuit plant near here, are virtually invisible, as I found when I examined a screen panel not

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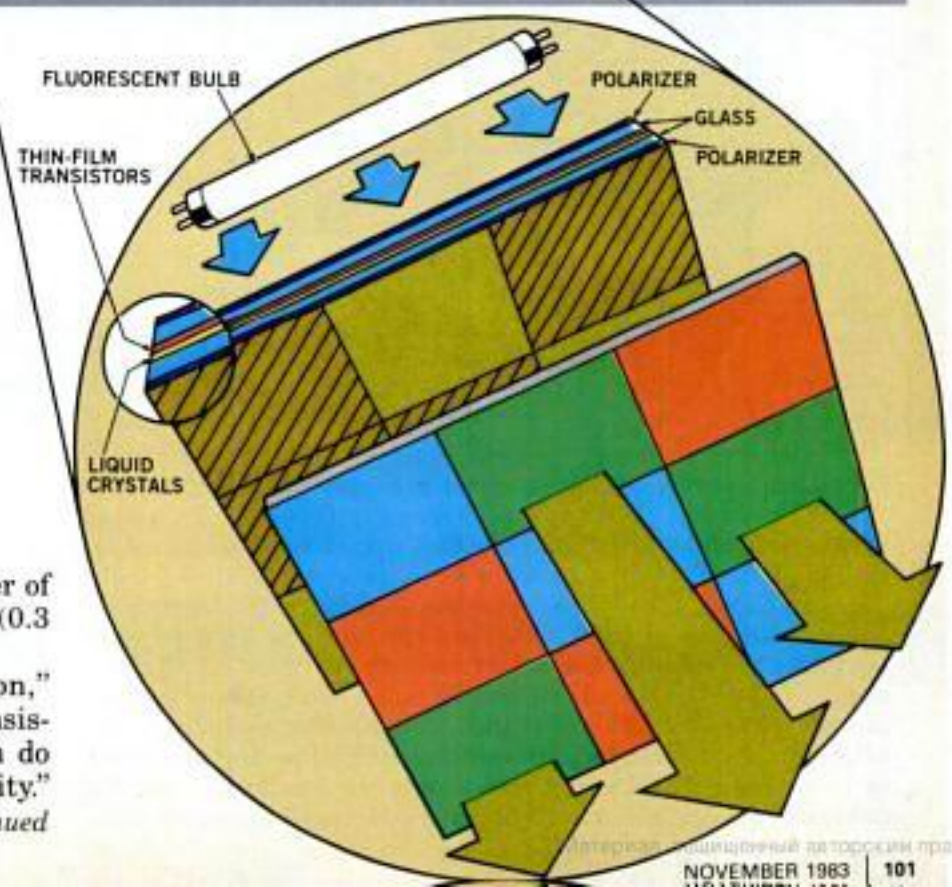
Heart of Seiko's new Pocket Color TV is the panel shown above. It's a sandwich encasing liquid crystals and a vast array of thin-film—virtually invisible—transistors. Liquid crystals form 57,600 matching pixels, or picture elements. Combinations of primary red, blue, and green elements form different colors. The exploded drawing at right shows how the green color on the screen is created. Varying voltages can change pixels from black to transparent. Black pixels (red and blue in diagram) block light; transparent ones allow light to pass and hit color filter. When the voltage is off, the green pixels are transparent; they allow light to pass and strike green elements on color filter. The result is green color on the screen. By turning voltage on and off in various combinations of primary colors, the overall color picture on screen is obtained.



enclosed in a case. The transistors are made on a layer of polycrystalline silicon only about 3,000 angstroms (0.3 micron) thick.

"We made the transistors of polycrystalline silicon," Morozumi said, "because conventional thin-film transistors made of cadmium selenide or amorphous silicon do not have sufficient stability, reproducibility, or reliability."

Continued

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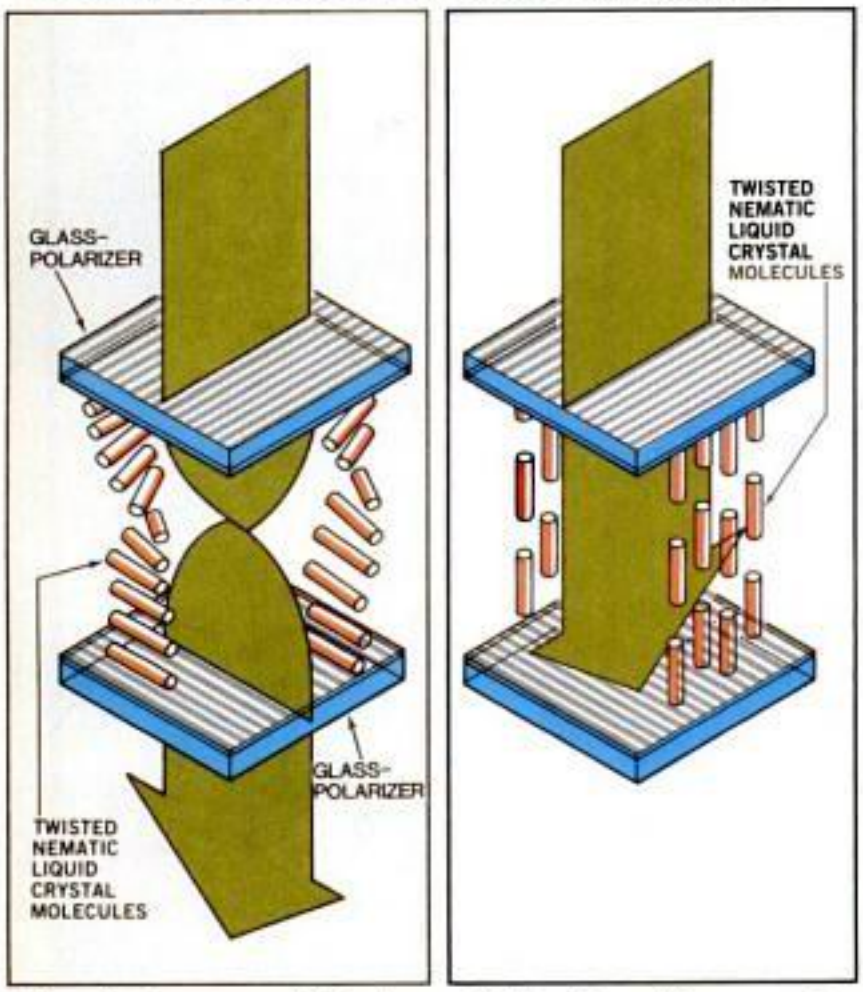
Tiny Seiko TV is slightly more than one in. thick. Measurements of the prototype are 6.3 by 3.15 by 1.1 in. It weighs 17.6 oz. Playing time is four hours on four AA alkalines.

How LCs are used to make a TV picture



New fast-response, twisted-nematic liquid crystals are sandwiched between glass light polarizers in the color-TV panel and activated by adjacent thin-film transistors. When an individual pixel is off, with no voltage applied (left), light passing through the first polarizer is twisted 90 degrees by the liquid-crystal material. This enables the light to pass through the second polarizer (which is oriented at right angles to the first) and to strike a color filter. When voltage is applied to the LC cell (right), the rodlike molecules are aligned. As a result, light passing through the first polarizer is no longer twisted 90 degrees and is blocked by the second polarizer layer. LCs in watches work in much the same way.

Additionally, polycrystalline silicon transistors have high contrast. "A conventional LCD does not have sufficient contrast," Morozumi said.

Overall, the picture on Seiko's tiny screen is adequate once you get used to squinting at such a small image. Close-ups, as in soap operas, are easier to view than distant shots. The colors, though not as bright and crisp as those on a conventional cathode-ray tube, are more than adequate. The reds seemed especially good.

Compared with the Sony Watchman [PS, Nov. '82], the Pocket TV's picture is more pleasing because of the color. Resolution appears to be about the same, even though the Watchman is a flattened CRT and not an LCD. Seiko claims the resolution of its Pocket TV is about 200 horizontal lines (seven lines per millimeter).

The Pocket TV picture is more easily viewed than that of the wristwatch TV that Seiko also makes. I haven't had an opportunity to view either the Casio LCD black-and-white TV that went on sale recently or the EXP Research shirt-pocket LCD TV ["What's New in Electronics," PS, Aug.] scheduled to go on sale shortly.

The Casio LCD screen is slightly larger than that of the Seiko Pocket Color TV—2.75 inches versus 2.13. Screen size of the EXP model is only 1.5 inches. The Casio unit has a backlight made of electroluminescent materials instead of the fluorescent tube used in the Seiko. The backlight is needed to provide uniform illumination during the day and for night viewing. Liquid crystals merely reflect light, and when the viewing area is dark the display cannot be seen without a backlight.

Plummeting prices

Sony started the pocket TV era with its Watchman, just as it launched the tiny-portable-stereo era with the Walkman. The Watchman is certain to get considerable competition from the Casio model, which is bound to drive prices down. The Watchman lists at $350; Casio has announced a price of $299 for the TV-10. EXP Research will price its unit at $275. The Seiko TV wristwatch sells for $495.

Seiko's Saito says the Pocket Color TV will be priced at between $400 and $500 when it goes on sale in mid-1984. Who will buy that kind of device for that kind of money? "We expect it to be a popular gift item," Saito said.

Many industry observers believe, however, that LCD TVs represent more than just another fad potential. There's considerable speculation about whether these small models could eventually lead to an enlarged flat-screen television you could hang on the wall. I asked Saito whether Seiko plans to build a new generation of LCD hang-on-the-wall televisions.

"Right now, we could build a five- or six-inch flat-screen TV," he told me. But he admits that the company hasn't yet done so. The reason? "It would be extremely expensive to do and would not be competitive with other types of TV," he explained. What about eventually building a large-size flat-screen TV with pocket-TV technology? "We could build a 12-inch screen for alphanumeric display at this time," Saito said. "You don't need the response speed for an alphanumeric display. But it is quite difficult to achieve a hang-on-the wall television using this kind of technology." As he thought more about it, Saito admitted: "It would be almost impossible to fabricate thin-film transistors on such a large area. Projection TV is an easier way to achieve a hang-on-the-wall TV."

At the same time, however, Saito told me: "We have yet another way to achieve the large screen area. It uses an altogether different technology, but I can't tell you about it now," he said teasingly. "Perhaps it will take five years—or even more—to achieve this large-area television." ■

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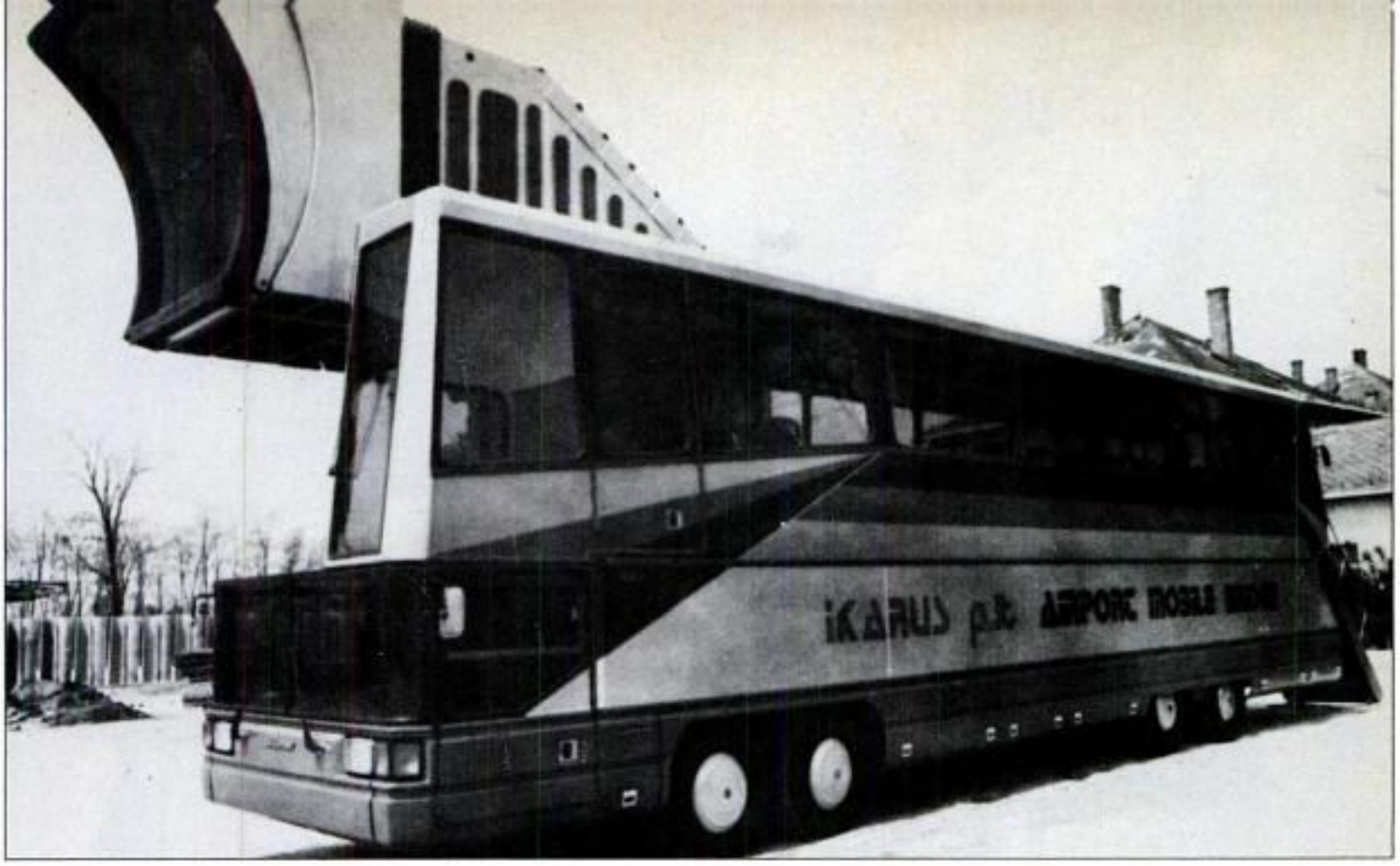
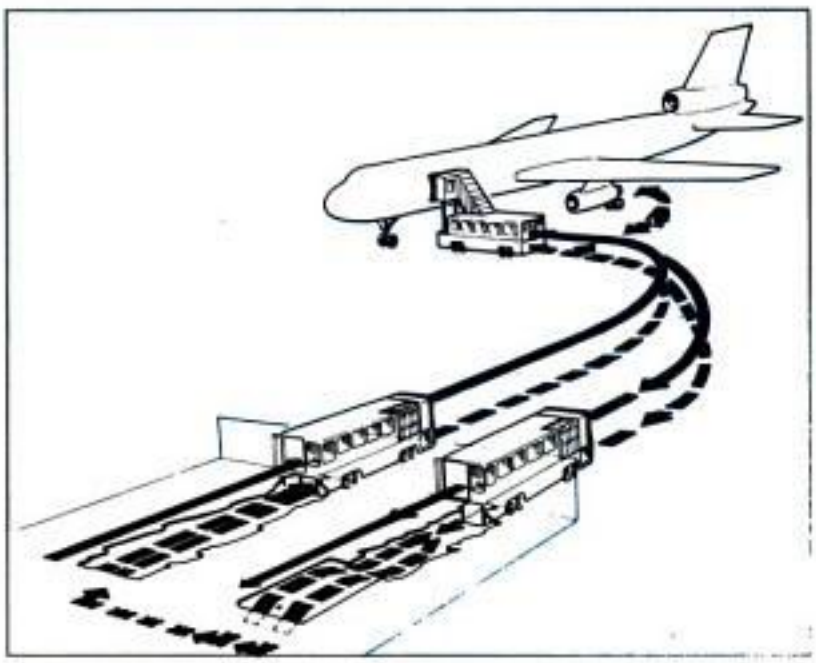


Door-to-door service aboard this

airport bus



A new bus, with a driver's position at each end, a built-in elevating stairway, and automatic baggage-handling equipment, will cut down on long walks, add to passenger convenience, and reduce airport-building costs. Prototype units are being tested in Europe.

By DAVID SCOTT

BUDAPEST, HUNGARY

One of the worst parts of flying is the long walk through an airport to your gate. And if this isn't irksome enough, there's always the walk at the end of the flight and the inevitable wait for your checked baggage.

But now a Hungarian company has devised a shortcut for foot-sore travelers. It's a bus called Aeropalt, for (Aero) Passengers and Luggage Together. Here's how it works: Check-in is at the departure door—the bus designated for your flight is waiting just outside the door. You drop your suitcase onto a pallet, place carry-on bags on an X-ray machine conveyor, and step through a metal detector.

The bus is docked end-on against the building, and you step aboard through its rear door. As each luggage pallet is filled, it's conveyed forward and down into the lower level of the bus. There, it's transferred to an underfloor conveyor running the length of the vehicle's body.

When the bus is fully loaded, the driver takes you to the aircraft, stopping just beneath the passenger door. He pushes a button, and a flight of stairs rises from one side of the forward third of the bus's main floor. You walk up the steps into the plane and take your seat. At the same time, the conveyor below discharges the baggage pallets out of the back of the bus onto an elevating loader truck.

At your destination the sequence is reversed. The bus is bidirectional. with a driver's compartment at each end. so the shuttle is speedy.

Aeropalt Ltd., a new Hungarian company created to promote this idea. cites several advantages of the system. aside from passenger convenience. Because baggage for a given flight stays with its owners, there's little risk of pilferage or of misdirected or lost bags. Terminal buildings could be smaller and less costly, with shorter causeways.

Prototype vehicles have been built in Hungary by Ikarus, Europe's largest bus manufacturer. Another version planned by Ikarus is a road vehicle plying directly between a center-city air terminal and parked aircraft. It would bypass the airport buildings entirely. PS

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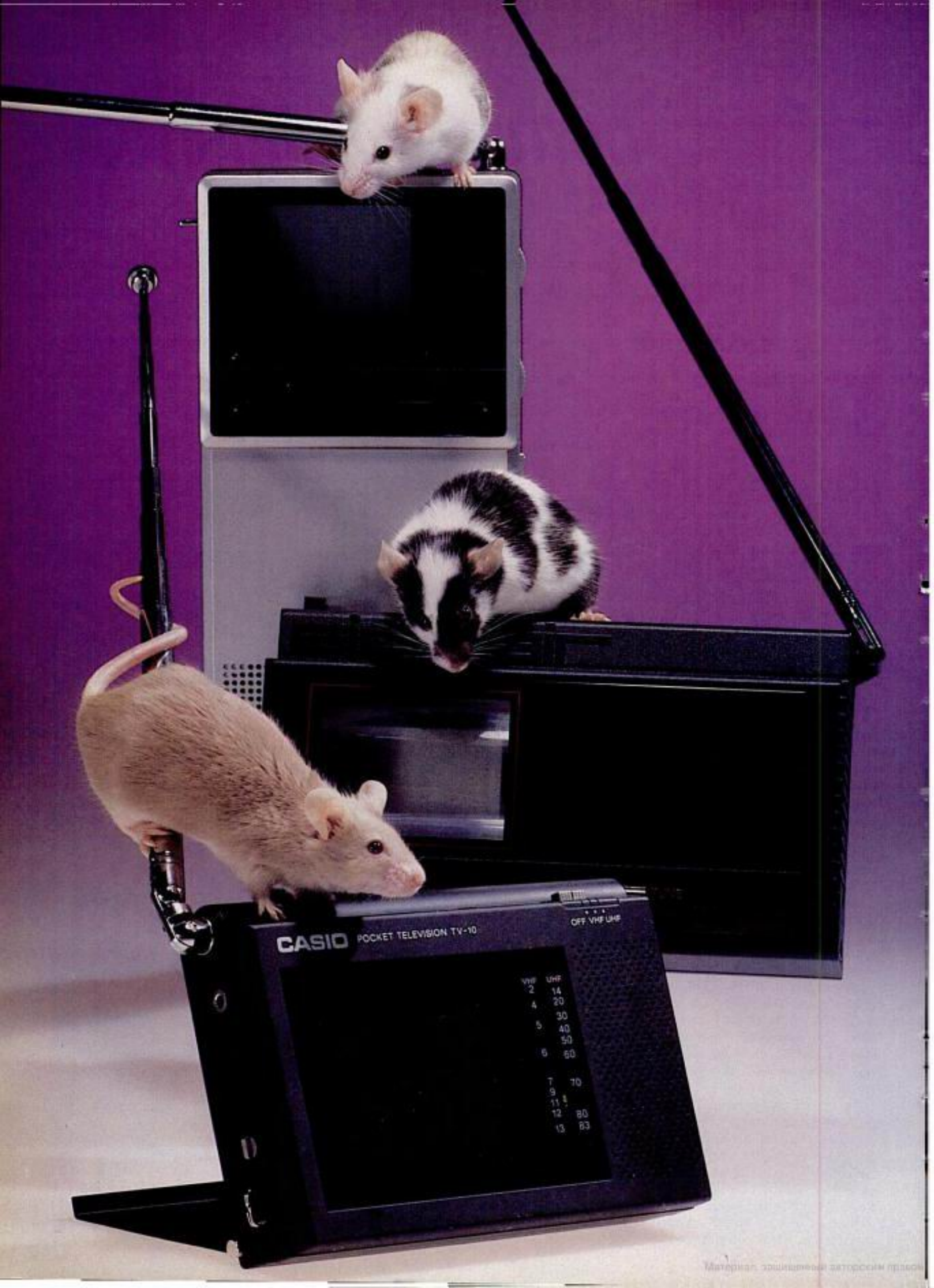

Материал, защищенный авторским правом

Flat screens shrink new pocket TVs

● New mini-TVs travel anywhere with you—or let you catch action up close at the ballpark. Flat cathode-ray tubes, complex liquid-crystal displays, and advanced single-chip TV circuits make these carry-along sets possible. Models with full-color displays will soon be available.

By JOHN FREE
Photo by Greg Sharko

At last, they're here. Flat-screen TV sets, always just around the corner, are now in stores. And more pocket-sized models are being introduced.

The sets, which provide viewable but detail-limited pictures, are being gobbled up by gadget-hungry shoppers. But whether they become a mass-market product, as have personal-stereo tape machines, remains to be seen.

I tried several of these remarkably compact sets and quickly noticed distinct differences in picture quality and channel-tuning sensitivity. Because the flat-screen market is so new and my sampling limited, however, direct comparisons of brands is premature. Before investing in one of these new sets, you should try it out if possible under conditions similar to those under which you'll be using the set.

Despite the variety of flat-screen technologies under development [PS, June '81], two of the black-and-white pocket sets use new versions of the familiar cathode-ray tube (CRT). The Sony Watchman FD-210, which appeared in 1982 ["Go-Anywhere TV," PS, Nov. '82], has a flattened, paddle-shape picture tube. Now the firm is marketing its second-generation Watchman, about 20 percent smaller and lighter—and less expensive—than the original.

Meanwhile, from a 19th-century water-bottling plant converted into research labs in Cambridge, England, inventor Sir Clive Sinclair hatched the pocket-sized model he's been developing for the past five years.

The Sinclair Research Ltd. model designed for European use ["Little Flat-Screen TV," PS, Dec. '83] is being made and distributed by Timex in Britain. The set, shown in dummy form on the facing page, also has a flat-screen CRT, but it draws relatively little current; the set is based on a single microcircuit—a combination that makes for a continuous-use battery life of about 15 hours, according to Sinclair. The UHF model distributed in Europe automatically switches to various 625- or 525-line TV standards. A newer model, with an additional VHF tuner for the U.S. (to be marketed in 1984 by Sinclair Research Ltd., 50 Staniford St., Boston, Mass. 02114), will retain this capability.

Casio is the only firm at this writing offering a liquid-crystal-display (LCD) monochrome pocket set. Seiko has an LCD wristwatch-TV model with a calculator-size tuner-amplifier [PS, April '83]. The Casio TV-10, with a 2.75-inch screen, uses the twisted-nematic type of LCD, similar to that used in watches and calculators. The TV-10 can use bright ambient light reflected from its thousands of tiny LCD elements; a switch activates a solid-state electroluminescent element behind the LCD panel to display pictures in dim light. LCDs have low power requirements and thus permit long battery life, but they often have poor picture contrast. This problem was evident in the TV-10 that I tried.

Although it's not yet in stores here, a color LCD pocket set from Seiko [PS cover story, Nov. '83] is expected to go on sale soon. According to PS Executive Editor Herb Shuldiner, who saw the prototype in Japan, the set displays a good color picture. In the second half of 1984, Sanyo is expected to market a color LCD TV with a three-inch screen (one inch larger than Seiko's). The Sanyo set is expected to sell for about $420 there. In color LCD sets, three LC picture elements, each with a color filter in front of it, are necessary to form a color triad—a red, green, and blue combination to form a color-picture element. Compared with a monochrome LCD set with the same number of LC elements, picture detail on the screen is diminished, but the color creates a more satisfying picture.

How popular will flat-screen pocket TV become? Says Clive Sinclair of his latest brainchild: "I believe that it and its successors can achieve for television what the transistor radio did for wireless—and create a new one-per-person product." PS

Flat-screen sets (from top: Sony FD-20A, Sinclair Pocket TV, Casio TV-10) are likely to multiply rapidly.

PS buyer's guide to flat-screen pocket TVs

Maker	Model	Price ($)	Screen size (in.)	Screen type	Size (H, W, D: in.)	Weight (oz.)	Battery type, life	TV standard*	Comments
Casio	TV-10	200	2.75	LCD	3 3/16, 4 1/16, 1	12	3 AAs, 7 hrs.	M	Has LCD backlight switch, brightness control
Sinclair Research	Pocket TV	About 100	2	CRT	3 1/2, 5 1/2, 1 1/4	10	Flat, 15 hrs.	B, G, H, I	Automatic TV-standard switching
Sony	FD-20A	200	2	CRT	6 5/8, 3 1/4, 1 5/8	18	4 AAs, 10 hrs.	M	Video-in (VCR) jack

*TV standard M is the 525-line-resolution format for North America and a number of other countries; B, G, H, and I are 625-line-resolution standards for Europe and Great Britain.

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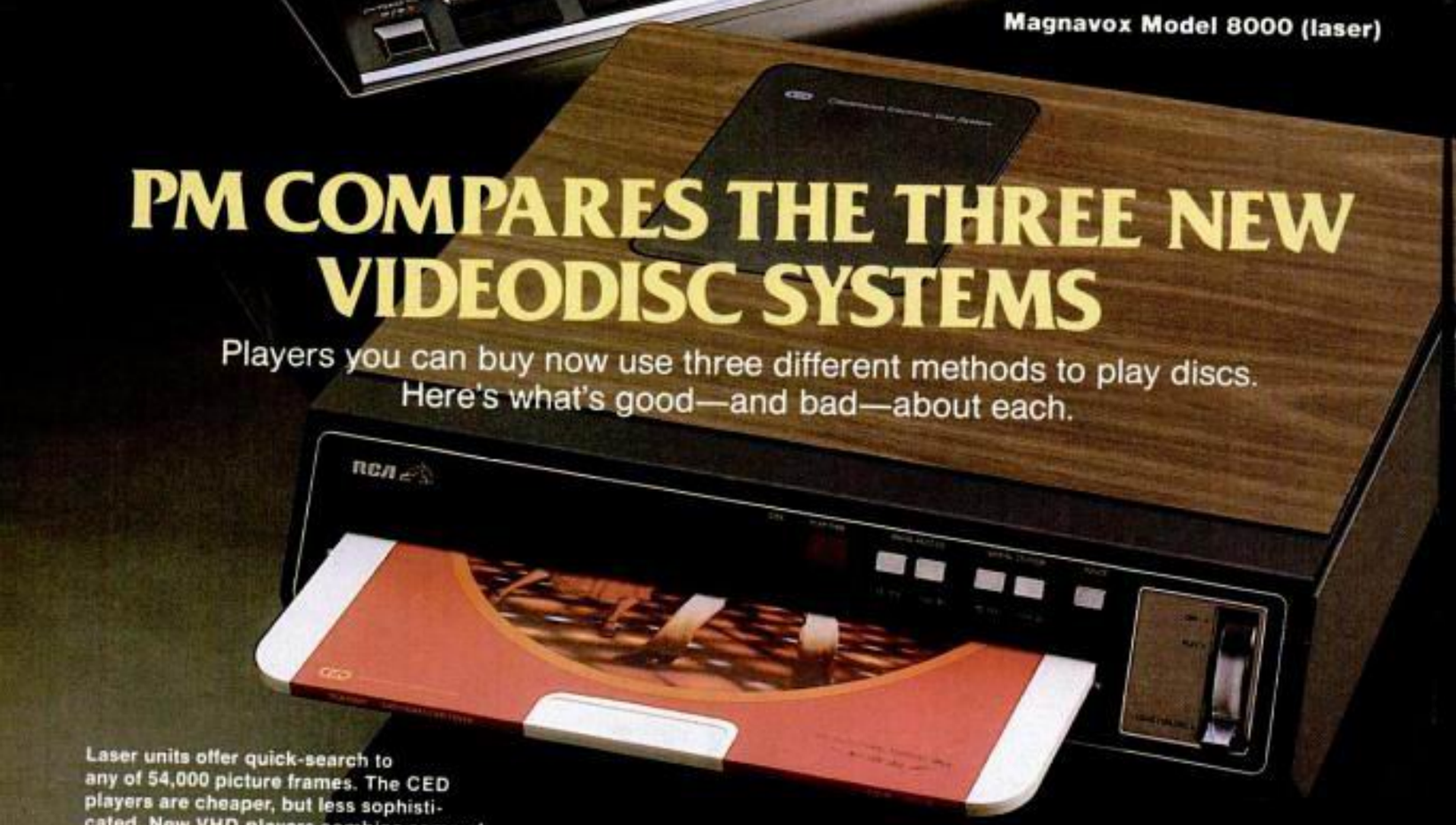
Magnavox Model 8000 (laser)

PM COMPARES THE THREE NEW VIDEODISC SYSTEMS

Players you can buy now use three different methods to play discs. Here's what's good—and bad—about each.



Laser units offer quick-search to any of 54,000 picture frames. The CED players are cheaper, but less sophisticated. New VHD players combine some of the laser abilities with lower costs.

RCA SelectaVision Model SFT100 (CED)

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GE videodisc prototype (VHD)

Elmo Video Disc Player VEC-200 (CED)

Pioneer LaserDisc
Model VP1000 (laser)

Laser system reflects laser light from pits on videodisc's mirror-finish surface. Amount of reflection controls the video signal. There is no stylus, hence no disc wear occurs.

CED, or Capacitance Electronic Disc, was designed by RCA. Stylus rides in groove and capacitance effect picks up video signal. Some players, such as Elmo Model VEC-200, also offer stereo sound outputs.

VHD stands for Video High Density. Information is read from capacitance pits of coated disc by a stylus that just touches the surface lightly.

by Neil Shapiro ELECTRONICS EDITOR

Round and round spin the three new videodisc systems, and the arguments for and against each one can be as dizzying as a ride on a runaway merry-go-round. Before you plunk down a good bit of money, here's what you should know. And even if you're not in the market, stay tuned: These videodisc machines use some fascinating technology.

Videodisc manufacturers are using three different systems. All three will bring movies and other visual entertainment to your home TV. They are all playback only (so far, no videodiscs can record). But their similarities end there. A disc from one system will *not* play on a different system.

The first system that came out was

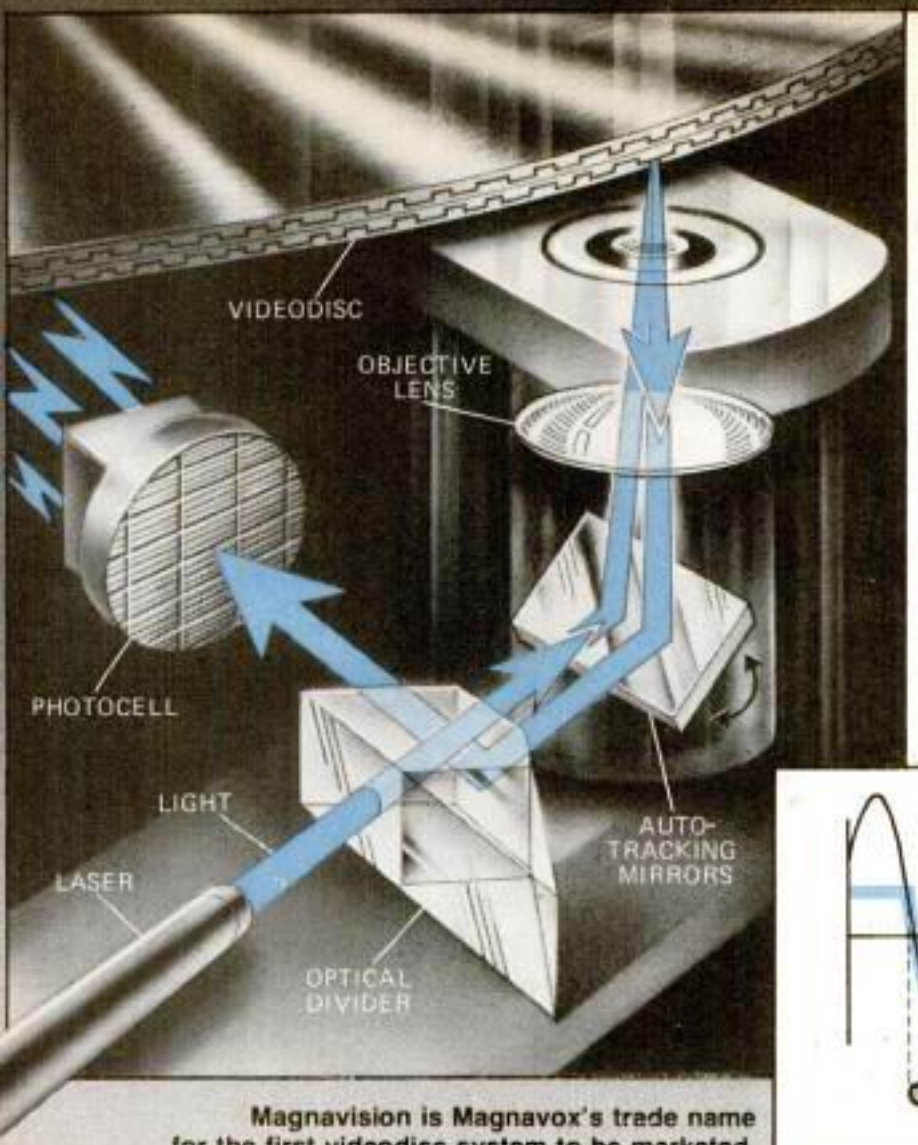
(Please turn to page 111)

The videodisc player offers many conveniences as shown here (top). You can return to the same scene over and over, fast-forward or reverse, even freeze-frame. The only thing you cannot do is record. Playing a prerecorded disc (bottom) is simply a matter of closing the lid and hitting play.

LENS
SEARCH REVERSE/FORWARD
INDEX
FAST FORWARD
NORMAL FORWARD/REVERSE
VARIABLE SPEED
SLOW FORWARD
SLOW REVERSE
STILL FORWARD
STILL REVERSE
DISC

PM's complete guide to the NEW VIDEODISCS and CASSETTES

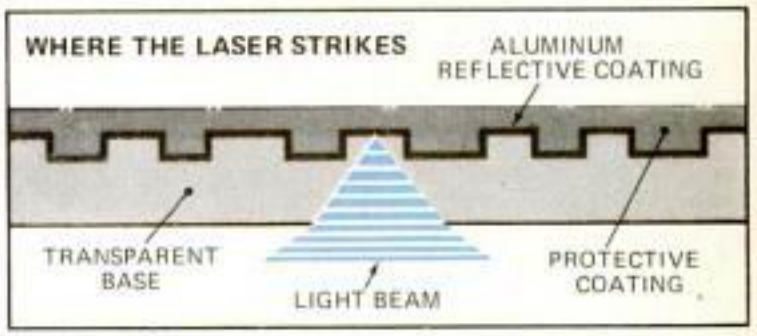
PM Photos: Frank Lusk

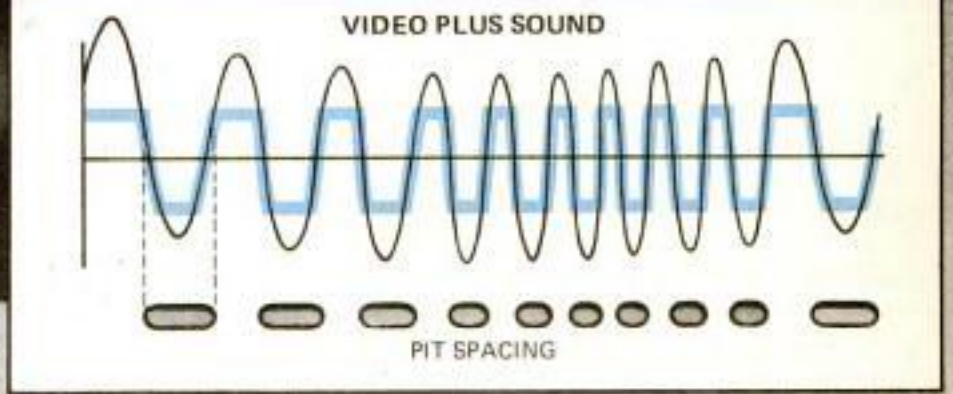


Magnavision is Magnavox's trade name for the first videodisc system to be marketed.

MAGNAVISION VIDEODISC SYSTEM

First videodisc system is Magnavision from Magnavox. It uses a laser to "read" digitally encoded discs. Laser light is focused, from below, on the spinning disc. The beam of light passes through a transparent base material which protects disc from fingerprints. It then hits optical pits on a reflective aluminum surface (backed up by a further protective coating). Light bounces back, changed by reflecting from the pits. Information contained in optical pits is further enhanced by spacing of the pits along a spiral track. Video and sound are both so encoded.





Choosing between one of the new videodiscs or video cassettes can be confusing. Here's what's available now—and what the near future holds in store.

by Stan Prentiss

You can team Quasar's VH5200 portable with its VA515 varactor tuner. This would give you microprocessor control, along with remote channel changing.

The videodisc is out to challenge the more familiar video cassette recorder/player. At least four companies, by the middle of next year, will offer new disc systems, each slightly or significantly different from the rest.

Conflict in the marketplace results from one simple fact: Video cassettes can record and play back off a home television or, with an accessory camera, can even take home TV "movies." Videodiscs *cannot* record; they only play back previously recorded movies or programs from discs reminiscent of stereo records—but the discs cost less than tapes.

Magnavox is first on the market with its silvery-plattered Magnavision disc system. Production has been currently sold out in test markets, such as Atlanta and Seattle.

Priced at $695, Magnavision operates on a laser-light system. The disc contains digitally encoded information "read" by the laser. There are rows of optical pits along the surface of the disc. A laser beam, focused from underneath the spinning platter, is bounced back, changed by the manner in which the pits have reflected it. It is this change which carries the information as to what the TV picture should be.

The disc is protected from fingerprints and other damage by a plastic coating. The discs are also aluminum-backed, so that they have a startling, rainbow-like appearance.

The videodisc can hook up to any TV right at the antenna terminals. Audio output is on two separate channels which are, of course, combined by most nonstereo TVs. Future possibilities would include such things as stereo or bilinqual sound tracks.

Each side of a Magnavision disc has a 30-minute playing time. Right now Magnavision offers such fea-

tures as fast forward and fast reverse, as well as slow motion in either direction. Each disc side can hold 54,000 frames. Every one of these frames has a reference or index number which can be displayed—and each frame can be frozen still. If you want to direct someone who has a videodisc to a favorite movie scene you could say, "Pull out frame 40,167 in *Casablanca*" and *know* exactly what he or she would see. Right now it requires fast forwarding and reversing to get to the right frame. In the future, the viewer will likely have immediate access to any single frame.

RCA is jockeying to have its own videodisc—a capacitance-stylus system—ready later this year. But informed sources do not expect to see it until 1980. The system has a diamond needle that will ride in grooves on the disc itself. It will measure the difference in electrical charge potential (capacitance).

The RCA system as yet has no capability for freeze-motion, and no slow or fast motion—only normal playing speed. It is somewhat subject to wear on both needle and disc, while a laser system (like Magnavision) has a life expectancy of at least 5000 hours of playing time.

One very important thing about the RCA system: It will likely be cheaper than its laser competition—somewhere in the $400 to $500 range.

Panasonic (as reported in last month's *PM Electronics Monitor* column) is currently considering a quartz needle pickup. The system would use the piezoelectric property of quartz (changing vibrations from the grooves into electrical voltage). The disc would be 9 inches in diameter and also subject to wear from the needle.

Video cassettes, such as this PV-1600 from Panasonic, point up differences between disc and cassette. As shown, this deck can use different video cameras to record home video "movies." It can also record off the air. Discs are play only.

JVC (Victor of Japan) is reputed to have a highly versatile videodisc system waiting in the wings. It is a needle-type system, but is said to have "electronic grooves" so the needle won't contact the record.

Pioneer is the only company besides Magnavox that—at press time—has a videodisc system actually on the market. Pioneer's is a laser system similar to Magnavox's although discs are not interchangeable from one system to the other.

Pioneer has yet to enter the consumer field with its videodisc, but it has already sold at least 7000 systems to General Motors. The units feature all the goodies, including stop-frame indexing and slow and fast speeds. They cost about $3000 apiece and come equipped with Zenith TVs and a big cabinet.

They will be used in promotional campaigns at the dealer level. Whether Pioneer intends to get the price down and sell to the consumer is yet to be seen.

On the cassette front

Things have not been standing still with the video cassette. The disc may threaten it, but since the disc cannot record, most see the cassette continuing for a long time to come.

What *is* new this year for these tape player/recorders is primarily extended playing time, some additional programming abilities and the introduction of *portables* (with both manual and electronic tuners) that can record or play for 30 to 80 minutes.

Less expensive table models feature mechanical tuners and single-channel programming, while their more expensive cousins have deluxe

Sony's SL-3000 is a portable video cassette that can team up with any Sony video camera. You can take it along, no matter where you go, for on-scene action.

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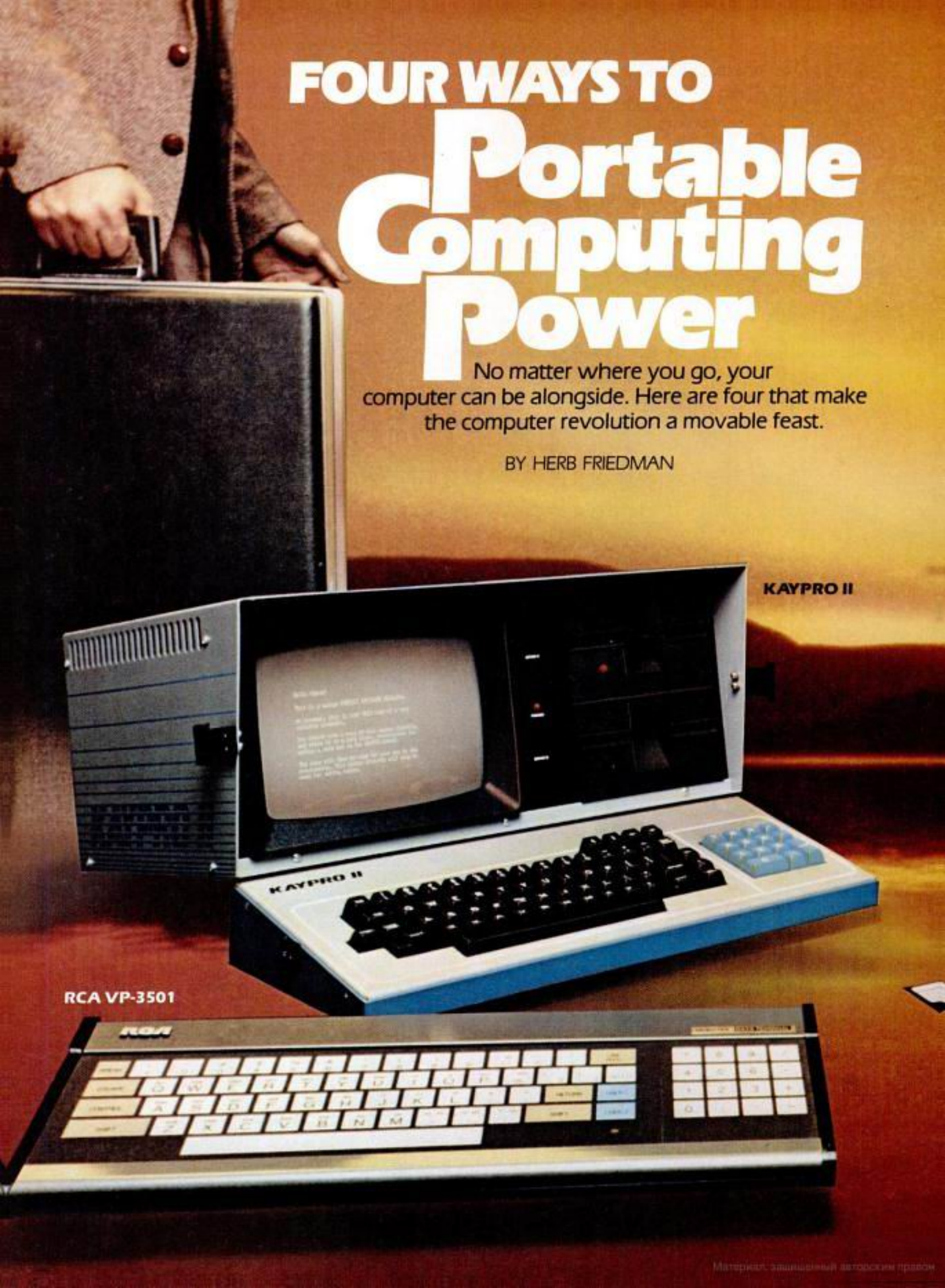
FOUR WAYS TO Portable Computing Power

No matter where you go, your computer can be alongside. Here are four that make the computer revolution a movable feast.

BY HERB FRIEDMAN



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Virtually unknown just a few years ago, the portable computer is fast becoming a success story. Though relatively light and compact, various models offer many of the features and performance of "full-size" desktop computers, yet they are small enough to fit under airline seats, be carried in a shoulder bag, or even slip into a standard attaché case. You can take them along on business trips and vacations, or on the daily commuter train. They can be set up quickly on the kitchen table, in a motel room, or even on your lap.

Our four computers are the Osborne 1, the KayPro II, the Epson HX-20 and the RCA VP-3501. (The RCA VP-3501 isn't really a computer, it's actually a videotex terminal which provides the user with computer and database services through information networks such as The Source and Dow Jones. But, in a sense, the RCA terminal serves as a "portable computer" because it can access computer and information services through the nearest telephone.)

The Osborne 1 is the model that introduced a wholly new concept in portable computing: that of a full-featured computer in a relatively light, easily carried cabinet. It is housed in a plastic cabinet that measures 5 in. wide x 13 in. deep x 9 in. high, and weighs under 24 pounds. Features include: 64K of RAM (memory), a built-in video monitor; an output for a dedicated communications modem (to send and receive data over a phone); an

Osborne 1 was the first of the portable computers and is still one of the top contenders. Complete with two disk drives and small screen, it arrives with a full software selection. KayPro II is similar in concept to the Osborne but has larger screen. It, too, comes with an impressive software collection. The Epson HX-20 can be carried in your attaché case. Its liquid-crystal display (LCD) makes the unit truly portable. The RCA VP-3501 isn't a computer—it's a terminal. Hooked up to a TV and phone, it accesses large computers.

PM photos: Lou Jawitz

KayPro II's keyboard features all the keys found on a full-sized computer, including a numeric keypad (above). It all folds together into a portable, easy-to-set-up package (right).

RS-232C serial I/O (input/output) for a printer or a communications modem; an IEEE I/O which also provides a Centronics-type printer output; an output for an optional, large, external video monitor; a connector for an optional, external battery power supply; two 5¼-in. floppy disk drives, each providing approximately 100K or 200K bytes of storage (depending on whether you purchase the single-or double-density computer model). The single-density model costs $1,795 (and might no longer be in production although still available in stores). The double-density model is priced at $1,995.

The Osborne 1 keyboard is part of the cabinet cover. It can be detached and placed about a foot from the computer. Just about everything else is on the main cabinet's front panel. A disk drive is positioned on each side of the panel and between the disk drives is a 2.6 in. × 3.5 in. video screen with a display 52 characters wide by 24 lines. Across the bottom of the panel are the battery power, external video, peripheral and accessory connectors, computer reset switch, and video brightness and contrast controls.

What really creates enthusiasm for the Osborne 1 is the supplied software package—its retail worth is almost equal to the cost of the computer. It consists of the CP/M disk operating system, MBASIC (MicroSoft BASIC), CBASIC (Compiler BASIC), *WordStar* (perhaps the most famous word processor), *MailMerge* (which does form letters) and *SuperCalc* (an electronic spreadsheet system). A special promotion deal also included *dBase II*, a rather expensive data management system.

In particular, the CP/M implementation for the double-density model is superb; it's many times more convenient than the standard CP/M implementation used in the old single-density model. The double-density CP/M is entry-level-user and applications-oriented—so simple even a child would have no difficulty—truly "user-friendly." However, *Wordstar* is almost a programming language in itself, with 149 individual command and formatting codes. While extremely powerful and flexible, it is somewhat difficult for the casual user to learn and use. The problem is compounded by the Osborne's 52-character video screen, which makes it extremely difficult to use the on-screen "help" menus that extend well beyond 52 characters, and which are important for the casual user. Also, since most business letters and documents are normally 60 to 64 characters wide, the user cannot see the actual document formatting on

RCA's VP-3501 is a videotex terminal which has no built-in computing power of its own. Instead, it connects via a telephone to computer networks or other computers and uses any television for display.

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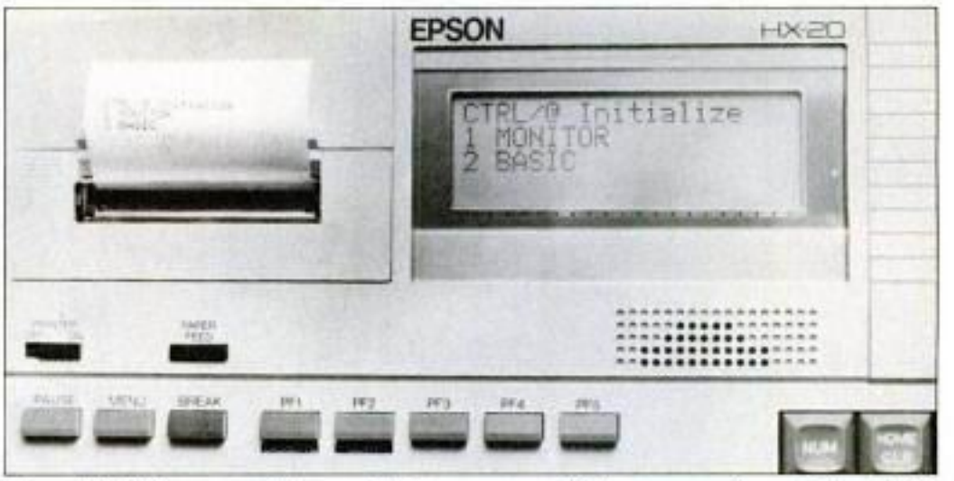
the Osborne's screen. While the Osborne's screen does a horizontal scroll if the user types beyond 52 characters, it's not the most convenient system to use if you want to search for something normally "off the screen."

But for those who want maximum convenience and flexibility in word processing, Osborne has an optional upgrade that provides an 80-character display. While 80 characters on the small, internal screen is almost illegible, it appears "normal" on a larger, plug-in monitor. The 80-character screen also makes *SuperCalc* (perhaps the most user-friendly Calc-type program there is) even better, as it adds at least three additional columns to the display.

A serious inconvenience that can affect the Osborne's use in an office or other "permanent" area is the location of the connections along the bottom of the front panel. The cables come out right on the keyboard, or they interfere with loading the left disk drive or viewing the screen. For those who have their printer or modem connected at all times, it's an important point to consider.



Epson HX-20 is an attaché-case-sized computer with features such as a built-in LOD display, a printer and a row of user-defined function keys, all shown above.

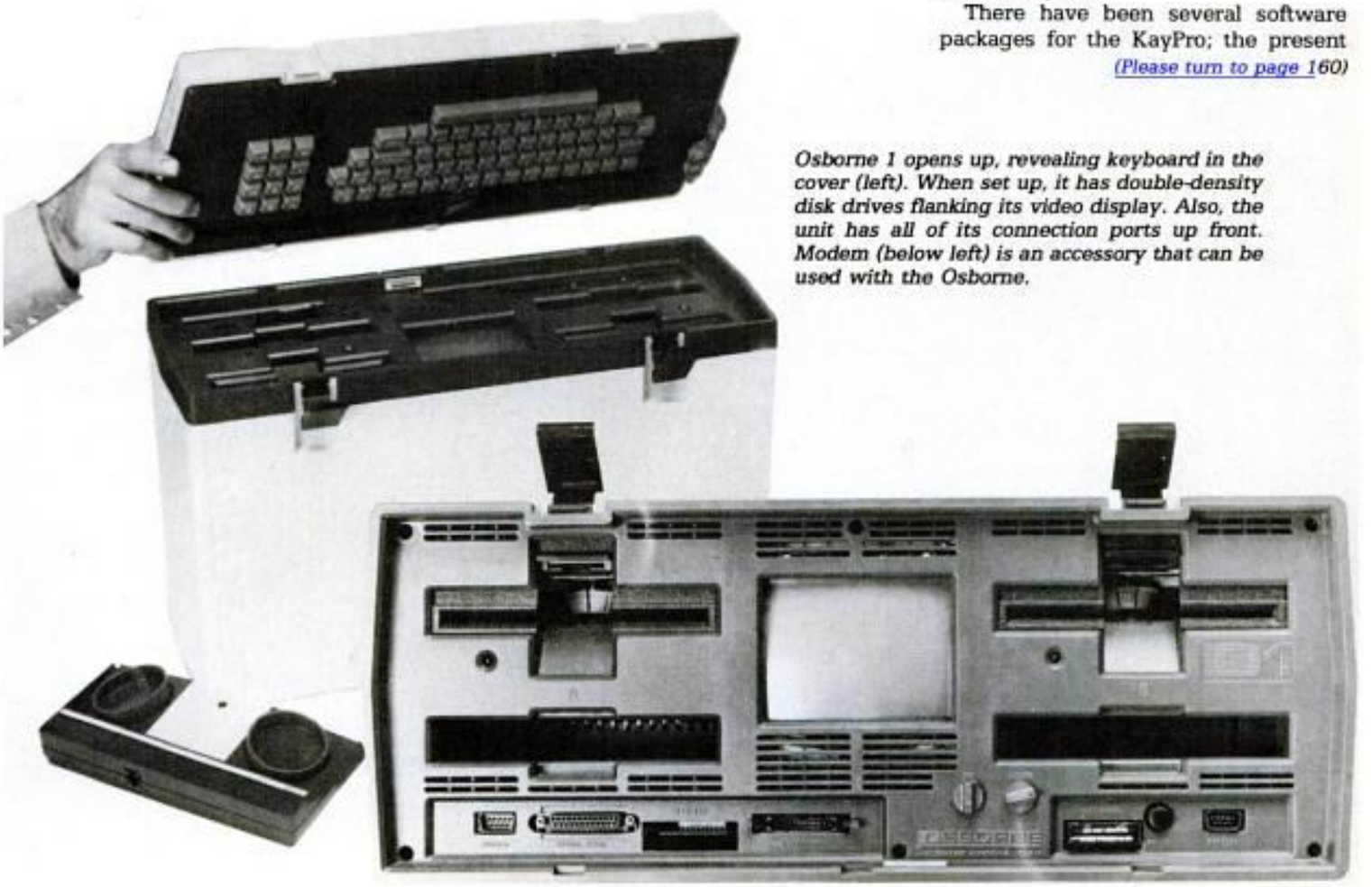
Big and bright

The KayPro II portable computer is similar in external appearance to the Osborne, and also comes with 64K of RAM. It is housed in a metal cabinet that weighs about 25 pounds. Overall, it's 18 in. wide × 16.3 in. deep × 8 in. high. The front cover is also the keyboard; it connects to the back of the main cabinet through the same type of coil cord used for modern modular telephones. On the back of the cabinet is the carrying handle, posts for wrapping the attached power cord, connectors for all standard printers, a video brightness control and the computer's reset switch.

Although externally similar to the Osborne, the KayPro II takes a somewhat different approach to portable computing. First, it is available only in its latest version, which is double-density, providing approximately 200K bytes of storage on each of two 5¼-in. disk drives. The price is $1,795. Second, and more important, it has a 9-inch, razor-sharp, 80-character, 24-line video display that takes up almost the entire left half of the main cabinet's front panel. (The two disk drives take up the entire right side.) Since 80 characters by 24 lines is considered "standard business" width for personal computers, all software provided with the computer—and virtually all you might purchase—will deliver optimum display on the KayPro.

There have been several software packages for the KayPro; the present

(Please turn to page 160)



Osborne 1 opens up, revealing keyboard in the cover (left). When set up, it has double-density disk drives flanking its video display. Also, the unit has all of its connection ports up front. Modem (below left) is an accessory that can be used with the Osborne.

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WATCHES
More Than A Good Time!

Today's marvelous watches let you watch TV, win sports car rallies and translate foreign languages. They even keep great time.

BY NEIL SHAPIRO ELECTRONICS EDITOR

Remember when watches had a big hand and a little hand and all they did was tell you the time? Well, today's electronic watches, with their sleek, liquid crystal displays and computerized innards, go much further than that. Telling the time is a sidelight now—sort of icing on the programmed cake.

Today's watches can do a lot more than tell you the right time. If you're an active person, they can do quite a bit to enhance your lifestyle. Now, we don't know anybody who actually owns *all* of these types of watches. But, if you will permit us a bit of whimsy,

SEIKO TV WATCH
(And FM Receiver)

PM photos: Bill Ashe

A wristwatch you can watch on your wrist may be in the near future. Seiko has unveiled its revolutionary new TV watch with a liquid crystal screen. The picture is clear and easy to see.

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"Get down" with a stereo watch and headphones (above), or get the word with an English-foreign language dictionary watch (right).

Be a sport and wear a watch like this Sports Timer (above), which will time all of your favorite sporting events. Or be a stay-at-home and calculate all of your household finances on this aptly named Budget Watch (top).

follow us while we detail an evening in the life of the mythical Thomas Tock, man about town and watch owner extraordinaire.

Stepping out

Tock, both his arms covered from wrists to biceps with the latest in programmed technology, is alerted to the evening's revels by the first of many insistent alarm beepings. Practiced eyes glance down the row of watches on his left arm.

Dexterously resetting the Marcel (Model 750) multi-alarm, dual-time zone watch, Tock sets out for a night on the town.

Sensing that he's making good time driving through the late-night traffic, Tock glances at his Seiko Tachymeter Sports 100 (Model MGL03) to check his average speed and estimated time of arrival.

Barreling through a sharp lefthander, Tock notices that the Seiko's tilted face allows him to keep both hands firmly on his silver Porsche's steering wheel. Finally, Tock pulls up in front of his favorite disco.

At the bar, he's amazed to find that

Now you can have entertainment on your wrist. In the roulette game watch, the wheel spins and realistically slows. Kopy Kat game watch is a rendition of the match-the-musical-note games. You can take on aliens in Star Trek's Wrath Of Khan. Or get closer to Earth and maneuver your tank away from attacking airplanes.

Casio's touch-sensitive face will make you wonder where the buttons went. Other calculator watches, such as the Armitron and Marcel, feature tiny but easily pressed buttons. Some calculator watches, such as Armitron and NSC models, include countdown timing functions.

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the bartender doesn't know how to make a Martian Wallbanger. Luckily, Tock's Edmund memo watch (catalog No. 33,217) saves the day. The watch's one-line display scrolls the list of ingredients in a manner reminiscent of the old Times Square marquee.

As the drink arrives, our hero cannot help but notice the dark-haired, sultry beauty who seats herself next to him. They turn to each other and she smiles and says something to Tock. After a moment of puzzlement, he realizes that she is speaking a different language.

The Casio Dictionary watch (TE-2500), worn high on his right arm, comes to Tock's rescue. Its Spanish-English and English-Spanish functions soon have Tommy and Estralita chatting—via his watch face—like old friends. Both, they find, are electronic game players.

With a flourish, Tommy unveils his Mercury Plane/Tank electronic game watch (3655) and it isn't long before the two together have saved well over a platoon of heavy tanks from being ravaged by dive-bombing enemies.

Near closing, the bartender presents Tock with the tab. Tommy nonchalantly picks up the itemized bill and clicks on the calculator display of his Casio touch-sensitive calculator watch (TC-500). The face clears to a flat display of calculator buttons. The heat-sensitive sections of the watch's face respond to his darting fingertips as he calculates the bill. He sighs. There's been no error and he reaches for his wallet.

His monetary problems fade as he enters the lovely Estralita's phone number and address into the two-line display of his Seiko memory watch (MGJ07M).

His pulse pounding (he checks this with his Edmund pulse watch, catalog No. 33,160), he offers Estralita the chance to accompany him home to see his etchings of rare old timepieces.

She smiles sadly. No, she sighs, and tells our man of the hour that she fears she has come down with a cold.

A quick check with the Casio temperature watch (TS-1000) confirms this fear. Not even Tommy's exciting presence could generate that high bargraphed reading.

Before leaving, alone, he checks his blood alcohol level on the disco's wall-mounted breath analyzer (that one's not yet built into a wristwatch). It's okay. He pulls out his car keys

(Please turn to page 126)

TIMEX 67731
(Sports Timer)
You can time individual laps with this sports timer watch (also available in men's version).

SEIKO MGM05M
(Rallye Timer)
Drivers will get supercharged performance and function out of this special timer watch.

EDMUND 33,218
(Jogger's Watch)
Joggers can set the pace with this watch and keep track of how far they run.

EDMUND 33,217
(Memo)
Keep a phone number handy with this watch and its one-line scrolling display.

SEIKO MGJ07M
(Memo)
A two-line display and calculator functions make this a real thanks-for-the-memory watch.

MARCEL 731
(Memo)
Scrolling memory display keeps track of events. Shoot-'em-up game helps pass time.

MARCEL 750
(Multi-Alarm)
Many watches feature multiple alarms. With a watch like this, you can beep day and night.

EDMUND 33,160
(Pulse Watch)
Ever want to take your pulse on the spur of the moment? This watch will do it for you.

CASIO TS-1000
(Temperature Watch)
This watch will keep track of your body temperature as well as your appointments.

ARMITRON 40/6351 (FM Stereo)
This FM stereo watch features an on-the-face tuning control, in addition to a power supply and headphones (not shown).

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RCA's New Multiscreen TV Lets You Switch to

With four black-and-white monitors and a 25-inch color screen, this television set of the future doesn't miss a trick—or a channel

By ARTHUR FISHER / *Group Editor, Science and Engineering*

The strange television set you are looking at will probably have a lot to do with the kind of set you'll be able to buy in the future, even though it is not for sale.

I first saw it in a top-secret room of an RCA plant in Indianapolis, Ind. There it sat, a 6½-foot-long box of smoky Plexiglas wrapped around five TV screens and some mighty fancy electronics. It was being readied for a smash unveiling before a meeting of distributors, but not as an item they could ever offer to the public. Then why was it built?

Wayne Evans, project engineer of the multiscreen set, explained that its design actually constituted an "engineering feasibility study." The question to be answered: If we wanted to build a no-holds-barred first version of a television and information center, using the latest technology, what would we get?

The answer was the one-of-a-kind set you see here, one that would let you, the viewer, keep an eye on everything going and then switch to where the action is. But how?

The set has four black-and-white monitor screens. Three are preset to the network (or any three VHF) channels in the area. The fourth screen shows another local station, or can be set to scan all other available channels, changing views once every few seconds. On command from a remote-control unit, which is keyed to the electronic heart of the set, the big (25-inch diagonal) main viewing screen—in color—picks up the program displayed on any of the four monochrome screens or displays UHF automatically.

The solid-state control circuits include both digital logic circuits for channel selection and switching, and analog memory modules for loudness, tint, and color. Use of these components means that all functions are electronically silent: There are no motors in the set except for one which, on command, sweeps the tuner through the 70 channels of the UHF band in less than six seconds. (UHF channel indication is digital, and thus highly accurate.) Mr. Evans and a colleague, engineering technologist Don Christensen, told me that much of the circuitry was adapted from the limited-run RCA-2000, a set that marked the first appearance of computer-type, logic circuit electronics in home entertainment equipment.

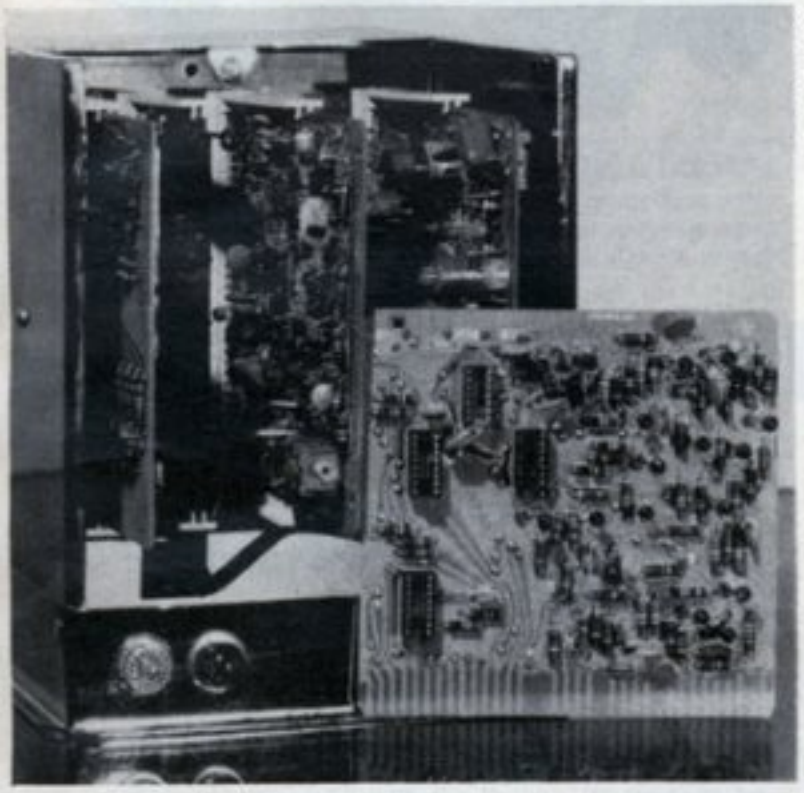
RCA's multiscreen has four monochrome monitors—three cover the major networks and the fourth can be set to scan any other stations you can pick up in your area.

Remote-control unit does everything—it selects channels, adjusts color and volume, turns set on and off, and also activates high-speed UHF signal-seeking system.

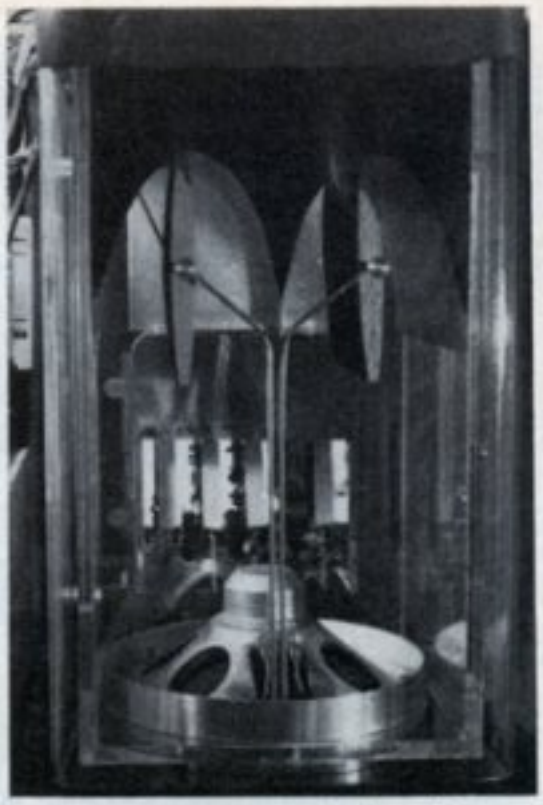
The set also embodies materials innovations that may show up in your set one day. T. P. Madawick, an RCA VP of Industrial Design Consumer Electronics, told how problems that arose in working with thick sheets of Plexiglas, chosen for its transparency, were finally solved with the help of Plexiglas manufacturer Rohm and Haas. And the sleeve that anchors the big color screen in place is a cast fiberglass yoke. This represents a materials breakthrough.

As an added fillip for the viewer who wants to keep posted on everything, two digital readouts constantly display the time and temperature. But you could adapt these features (in a set of the future) to your own special needs—for news, say, or stock quotations. You could rig a meter to tell you the pollution index. And if you had hay fever, you could even get the pollen count.

Where the Action Is

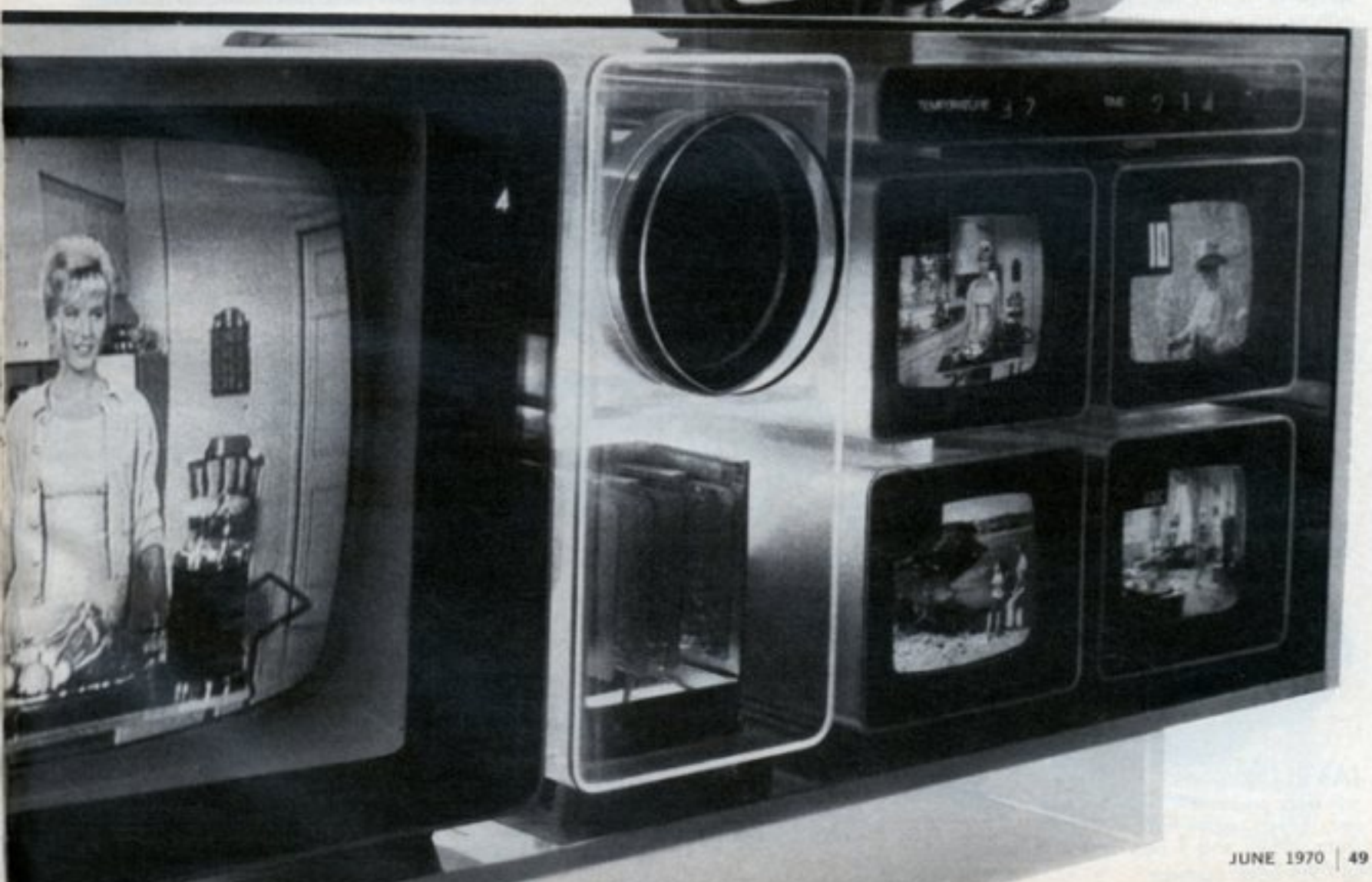


Solid-state logic circuits interpret signals from the remote control, switching the channel you choose for viewing from the monitor screens over to the big color tube.



Acoustical problems of see-through plastic speaker enclosure are solved by use of fiberglass insulation (black area at top of photo). Mesh parabolas conceal fiberglass and direct stray sound waves into sound-deadening baffles at their foci.

Wayne Evans, multiscreen project engineer, calls the set a "feasibility study."



For TV on tape: buyer's guide to **home VCR's**

Now you can double the speed, stop the action, and program a week ahead

By JOHN FREE
PHOTOS BY ORLANDO GUERRA

Video cassettes are contrasted with audio cassette (left). A protective tape cover on Beta (middle) and VHS cassettes flips up during loading.

Walter Cronkite seemed hyperactive behind his news desk. Reporters, politicians, and generals on the *CBS Evening News* scampered about like Keystone Cops. The reason: I'd just pushed SPEED PLAY, a button that doubles tape speed on a new JVC video-cassette recorder (VCR). If you can stand the pace, it's possible to watch a half-hour taped news program in 15 minutes.

Continued

Film converter is used to transfer movies or slides onto video tape. Images are projected on front of Quasar's KT502 ($130); TV camera fits on the side.

Cassette compartment on Hitachi's new two/four-hour VHS deck (VT-4200) flips up at an angle for loading. One key is pressed to begin a tape recording.

Four pushbuttons in covered compartment of RCA VCT400 are used to program selections up to one week ahead. Digital readouts display day and time.

Built-in timer on Sony's latest model (8600) is used for automatic operation. Earlier models have a separate plug-in timer. Deck has a remote pause control.

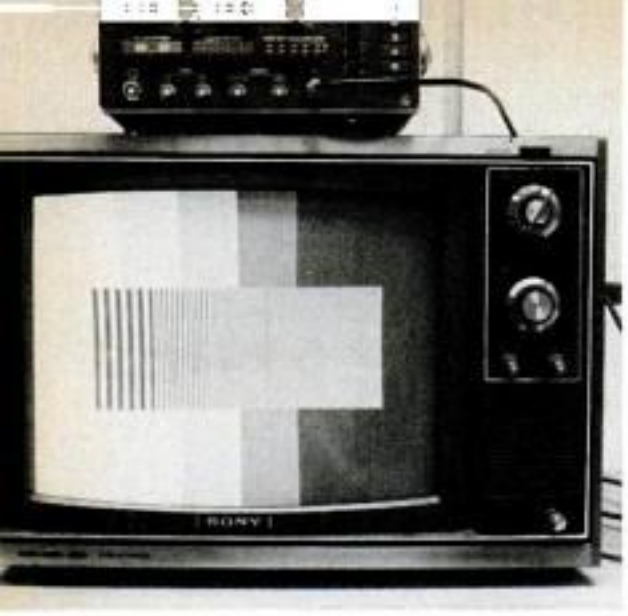
Remote control for JVC's speed-play feature lets you zip through taped commercials at double speed. A similar switch for remote pause is on 3600 deck.

Antenna connections on home VCR's route incoming TV signals through deck, back to TV. Cable TV requires two converters for full VCR capabilities.

Home-theater concept combining a projection TV and VCR is becoming popular but is still costly. Setup here uses Sony's deck, twin-lens TV with 50-in. screen.

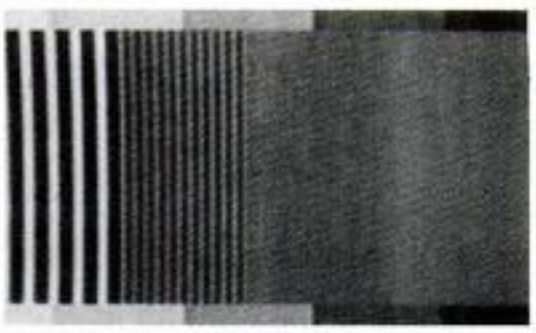
New VCR models tested include (from top) JVC HR-3600AU, Hitachi VT-2400, RCA VCT400, and Sony 8600. JVC model is lightest (30 pounds) and most compact deck, although camera angle here creates different impression. The RCA and Hitachi decks have switches for two-hour VHS tape recordings or a slower four-hour tape speed. The single-speed JVC can tape up to two hours on a VHS cassette; Sony's single-speed VCR tapes up to three.

Color TV cameras plug into VCR's so you can tape your own shows. Some models cost about $800, but options like the zoom lens on this RCA boost prices.

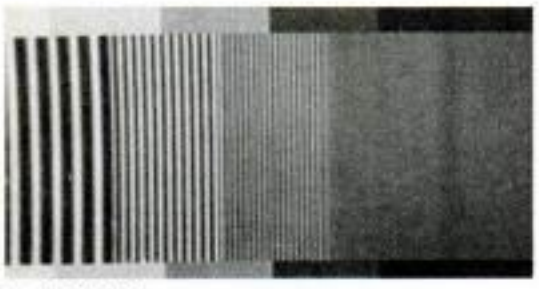


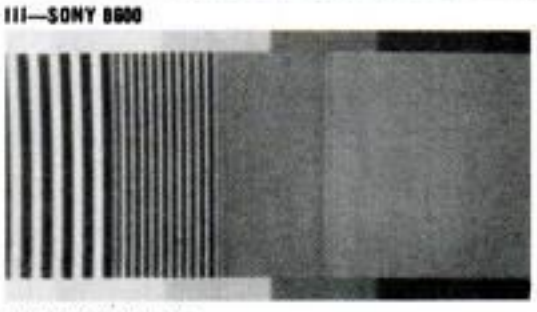
I—RCA VCT400

II—JVC HR-3600



III—SONY 8600





IV—HITACHI VT-4200

Resolution: how five models compare

Four new VCR models and the author's older RCA VBT200 at home were tested with signals from a new $1495 Philips pattern generator (PM5519). For comparisons, the three decks with four-hour long-play (LP) modes, RCA's VCT400 and VBT200 and Hitachi's VT-4200, were used in the standard-play (SP) two-hour mode.

Programs taped off the air and played back were reasonably sharp and free from noise (specks). In the LP mode, both RCA machines had pictures that were somewhat softened and had a little more noise than in the SP mode. The Hitachi deck had appreciably more noise and less distinct pictures in the LP mode.

Since it's difficult to compare resolution or picture sharpness from broadcast programs, a pattern from the signal generator (above left) was recorded with each deck. The inner block of closely spaced vertical lines is produced by five gradually increasing frequencies. The lines farthest apart on the left are produced by a 0.8-MHz signal; remaining lines, by 1.8-, 2.8-, 3.8-, and 4.8-MHz signals.

The Sony receiver (and most sets) could not display the 4.8-MHz signal. But none of the decks could capture and display the 3.8-MHz lines, which represents picture details you'd lose. RCA's VCT400 (and VBT200, not shown) displayed the 2.8-MHz frequency best, almost matched in resolution by the JVC HR-3600. It was barely visible from Sony 8600 and obscured by the Hitachi deck.

Earlier, I programmed a microcomputer circuit in RCA's newest, feature-packed VCR that can turn itself on and off, change channels, and record four different programs during the week by itself. These features can be very useful.

Speed play, stop action, one-week programming—they're all special features in the latest batch of home VCR's designed to snag potential buyers in a market that now offers many models. With some one-million home VCR's whirring away in homes this year, manufacturers are taking aim at tens of millions of TV homes without the compact recorders.

Everyone seems fascinated by the VCR's capabilities: Slip a paperback-book-size tape cassette into a video recorder and you can tape *The Martian Chronicles* being aired on one channel while you watch, say, CBS's *Thursday Night at the Movies* on another channel. Set a timer and a VCR can capture the *Late Late Show* while you're asleep or CBS's *Sports Spectacular* if you're out.

Plug in a black-and-white or color TV camera and you can tape your own TV productions. You can even buy battery-powered decks to record outside your home [see "Color TV Cameras Team With New Portable VCR's," PS, Nov. '78].

A remarkable number of firms have suddenly appeared that market prerecorded cassettes (see box). And if you have a TV camera you can transfer 8-mm home movies or slides onto video tape, or send film out to firms like Fotomat that put film on tape.

I've been testing four of the latest VCR models, indirectly comparing them with a model that I've been using for a year (RCA's VBT200)—a deck already phased out in this fast-moving field. With a good input signal, all of the decks tested can provide satisfactory color pictures. With test signals, however, it's quickly apparent that all of the VCR's lose picture details—some more than others (see box).

Time wars

Despite new features such as variable tape speed and microcomputer circuits, VCR makers have stuck with two unofficial and incompatible tape formats: VHS (for Video Home System) and Beta. Both formats use half-inch-wide, high-density tape to capture high-frequency video signals.

Look at the ads and you'll see that a battle of VCR playing times is raging. Sony introduced its Beta format four years ago with a machine that can record up to one hour on a single cassette. But in 1977, JVC brought out a VHS deck that can record two hours per cassette. Sony, using technology pooled with other firms, countered with a two-speed deck that can record either one hour or two on a cassette, depending on the position of a switch. When Zenith decided to market a Sony-made Beta-format deck two years ago, VCR's got a big boost in this country.

RCA, working with Matsushita, then introduced a deck made by the huge Japanese company that can double VHS playing time to four hours. Since that 1977 introduction, many other firms have joined in marketing both VCR formats (see table).

The battle over playing times for decks is likely to continue. Recently, Sony introduced limited quantities of a longer-playing Beta-format tape. It extends playing time on the now-standard slow speed to three hours. The tape is thinner than normal, which can make pictures somewhat noisier, and has a tape-tension problem that may create recording difficulties with some decks. Dealers can adjust decks to accommodate the thinner tape.

According to a Panasonic official, tape manufacturers are working on a longer-playing VHS tape, too, but deck makers want to avoid the problems Sony has been having. The new VHS tape reportedly extends playing time to six hours.

Last year, Sony was demonstrating an add-on cassette changer that pops another cassette into Beta-format decks when the first cas-

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sette runs out (for six hours' playing time). But at this writing, Sony is still field testing the changer on the West Coast.

Donald Duck cure

Some of the special features built into the higher-price models might be useful to you or your family, depending on TV viewing preferences. Sports fans can easily settle disputes over tags at home plate or football fumbles with the freeze-frame features on JVC's HR-3600 and Hitachi's VT-4200.

The JVC deck stops the video action when you press either the pause key or use a remote-control cord plugged into the deck. I found that adjustment of the front-panel tracking control is usually necessary to eliminate a narrow bar of noise in the picture. Taking into account the diminished picture resolution all home VCR's have, JVC's freeze-frame picture quality was excellent. The Hitachi also freezes TV frames if you use a remote-control attachment.

An important ingredient in JVC's speed-play feature on the 3600 is the special digital audio circuits. Without them, the doubled playback speed would produce an unintelligible Donald Duck quality to voices. A digital conversion and sampling technique [PS, Jan. '75] is used. The audio still doesn't sound normal, but it's understandable. And while you may not want to regularly halve the viewing time of programs, speed play lets you quickly locate a section of tape for viewing, or gets through taped commercials painlessly.

At this writing, only the Matsushita-built two/four-hour VHS programmable is available from RCA, Magnavox, and Panasonic. The RCA version I tried is moderately complex to program, although it no doubt becomes easier with practice. Within the four-hour limit of VHS cassettes and the seven-day restriction on programming ahead, there are many ways to tape programs.

Presetting VCR's to tape something when you're out or asleep is easy, but it's easy to goof, too. The first time I set my VCR to record a movie at 2:20 AM, I left the VCR/TV switch in the TV position. When I rewound the cassette to watch the movie, the TV screen was blank.

More recently, I consulted *TV Guide* and set my VCR to record a Stanley Kubrick favorite at 2:10 AM. Bad luck. The station didn't tell *TV Guide* about its extended news programs, so the machine didn't tape the last half of the film.

With model changes occuring so rapidly, you may be seeing advertisements for VCR "bargains." In some areas, Quasar's original "Great Time Machine" VCR (VR-1000) is being discounted to half the list price of most decks. This model, however, does not use standard VHS or Beta tapes, so you'll have difficulty finding prerecorded cassettes. Also, tests show this deck does not have the picture quality of newer models, such as the VHS deck Quasar also markets.

Older Sony models, such as the original one-hour-only deck, might not be a bargain, since it would not play tapes made with slower-speed, two-hour Beta models.

Stereo decks

As model lines expand, you'll see other innovations. JVC reportedly will have a deck that records audio in stereo. The TV industry in this country is just starting to seriously discuss stereo TV sound. But if you have simulcasts in your area (FM stations broadcasting TV audio), upcoming models will enable you to preserve video concerts with stereo sound on cassettes.

Software firms will be quick to exploit prerecorded stereo TV tapes, too. Soon you'll be able to walk into a record store and select a stereo video concert of your favorite performers. PS

Hollywood first-run films on tape for home VCR's

Prices are still high for prerecorded cassettes of movie features ($50 to $80 or more), and perhaps only 20 percent of VCR owners buy them. But a growing number of firms is entering this new home-entertainment field, offering everything from Chaplin classics to G, PG, R, and X-rated films on cassette. Also, despite FBI arrests, there's an increasing volume of bootlegged (illegally recorded) tapes such as *Star Wars* that may sell for hundreds of dollars each.

Magnetic Video Corp. (Industrial Park, Farmington Hills, Mich. 48024) has started a club that provides cassettes to VCR owners who don't have prerecorded-cassette dealers in their area. And soon you may be able to buy non-bootlegged cassettes of major motion pictures shortly after they're released in theaters and before they're offered to pay-cable firms and the TV networks.

The $3 "Video Programs/Index" (923 6th St. SW, Washington, D.C. 20024) is a regularly updated listing of firms offering prerecorded cassettes, including tape formats and subjects available.

What's available in VHS and Beta video recorders

Brand/model	List price ($)
2-HOUR VHS TAPE FORMAT[1]	
JVC HR-3300	1050
JVC HR-3600[2]	1335
MGA HS100U	n.a.
2/4-HOUR VHS TAPE FORMAT[3]	
General Electric 1VCR9000W	995
GTE Sylvania VC2450	995
Hitachi VT-4200	995
Magnavox 8220[2]	1075
Magnavox 8225[4]	1295
Panasonic PV-1100[2]	1095
Panasonic PV-1500[4]	n.a.
Quasar VH5010	1100
RCA VBT200[5]	1000
RCA VCT200	1000
RCA VCT201[2]	1075
RCA VCT400[4]	1275
1- OR 2-HOUR BETA TAPE FORMAT[6]	
Sony 8200	1095
Zenith JR9000W	995
2-HOUR BETA TAPE FORMAT[6]	
Sanyo VTC9100A	995
Sony 8600	1095
Toshiba V-5310	1100
Zenith KR9000	995

NOTES: (1) Tape manufacturers are working on a 50-percent extended-play VHS cassette that would enable VHS decks to play three hours or six hours. (2) Features freeze frame, slow motion, and double-speed playback. (3) Shut-off time may be preset. (4) Programmable: Four programs can be recorded while you're away for one week. (5) Model has been phased out. (6) At this writing, only limited quantities of 50-percent extended-play Beta tape cassettes have been made available, permitting three hours of play on newer single-speed Beta-format decks.

Sears offers a two-hour Beta-format deck. Montgomery Ward has a two/four-hour Panasonic VHS deck. J. C. Penney sells the RCA VBT200 two/four-hour VHS deck.

Some models of the Sony model 7200 one-hour deck may still be sold.

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A sampling of new phones—back row, from left: Freedom Phone from Royce Electronics, $449.95; Rova/Pro from Fracom/Rovafone, $649.95; two new styles by TeleConcepts, about $125 to $250. Second row (from center): Model 10-DCP Data Phone, $275; Superphone from ICP Marketing, $229.95. Skinny upright is Adonis G, Allied Telecommunication, for $130. Third row: Futura by Remco, $99.95; the Modulus 3000, $89.95 and Satellite Speakerphone, $259.95, both from Tele-Devices; Rapidial from Technology Applications costs $89.95. Round receiver attachment is the Soft Touch from Buscom Systems, $35. In hand is GTE's Flip Phone, $49.95. Travel Electronic's Aristocrat (right) lets you call to say you've missed the train—even if you haven't got a dime. But you'll have to spend $3895 first. Self-contained, it goes *anywhere*, calls anywhere in the world.

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Plugging into Bell

It's a new gadgety world when you own your own phone

It's legal now. Choose from a wild array of phones you could never get before

By LAURA WESSNER

Last month, a PS editor moved into a new Manhattan apartment. He equipped it with three new phones—none of them, however, from the telephone company. He bought them from a local store and simply plugged them into jacks supplied by Ma Bell.

Our editor is one of a growing number of people who are buying their own phones instead of leasing equipment from their phone companies. Here's why:

- It's now legal.
- You can save money.
- You can get more technologically advanced equipment, with more features, than Bell presently supplies.

What kinds of features can you expect to find? The new phones are laden with pushbuttons, digital readouts that tell you how much your call is costing, call-hold buttons, instant dialers, built-in speakers, alarm-clocks, full-function calculators, limited portability (for making calls from within ⅓ mile of a base unit), and full portability (enabling you to go anywhere and call all over the world). There are also more lightweight, compact phones and stylish decorator models.

Two phones incorporating many of these functions are included in the upper photo, facing: the Superphone and the Data Phone 10-DCP. The most completely equipped phone-company models contain only about half of the features found in either of these do-all units, which:

- Store 20 numbers for instant dialing.
- Recall the last number dialed, holding it in a memory until you dial a new number.
- Calculate to eight digits even while you're talking.
- Have digital readouts.
- Are alarm clocks.
- Display the time of day and date.
- Work as stop watches, so you can time conversations and cost.

There are other novel models. Flip Phone is a very light folding phone with a solid-state miniaturized microphone in its main body. The Futura by Remco redials busy numbers, puts callers on hold, lets you dial numbers without picking up the receiver, and lets you hang up when someone puts you on hold—it has a built-in speaker that lets you hear the calling party come back on the line.

Continued

Sophisticated electronic circuitry distinguishes the new do-it-all pushbutton phones from the conventional rotary-dial-type phone shown at the rear.

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A

B

C

D

E

F

A: Hands-Free Speakerphone from General Telephone & Electronics (GTE) allows you to talk with or without the handset; it has recall and mute buttons, and sells for $299.95. B: "Sculptura" from AT&T comes with rotary or "Touch-Tone" dialer for $65. C: Touch N' Talk automatic dialer from Telecomputer Corp. attaches to your telephone for $189.95 and stores 32 numbers for calling at the touch of a button. D: Compact Speakerphone from GTE is $199.95; it frees both hands to write or read and can be used up to 20 feet away without shouting. E: Set the Alarm Clock Phone from IT&T ($100) to wake you up and make your call. F: Port-A-Tel from Specialized Systems, Inc. connects to phones of those who are hard of hearing. Type in message on keyboard—32-digit display lights

Portable Rova/Pro has a ⅓-mile operating range, automatic re-dial, and is suited for use at work or recreational sites. Freedom Phone makes or answers calls up to 300 feet from its base station, which connects to a standard phone outlet. The Modulus has re-dial memory when you call a busy number. Simply press the button with the asterisk and it re-dials the number until the call is completed; memory is erased when you dial another number.

The Satellite Speakerphone lets you talk as you move around the room, or it lets the whole family join in a conversation. It also works with your conventional phone for privacy. Tele-Devices claims its sound quality is as good as a standard telephone's. The Adonis G hangs up when you put the phone down. It memorizes the last number dialed, and has a silence button so you can talk to someone in the room without the calling party hearing you.

There are also accessories that extend the performance of conventional phones. The Soft Touch replaces the bottom half of your receiver, to convert a rotary dial to pushbutton dialing. Rapidial stores 21 10-digit numbers, has LED display for verification of the number dialed, and dials at the push of a single button. It plugs into any phone, and an internal speaker lets you hear a busy signal before you pick up the receiver.

A year ago you couldn't legally plug many of the phones and attachments described above into the Bell system. And when you leased your phone from the local phone company you had to choose from a limited number of styles and colors. A December '77 ruling by the FCC changed all that by simplifying requirements for connecting privately owned phones to the Bell network, as long as the equipment is compatible with the network or registered and approved by the FCC.

But, says Adrien Auger of the FCC: "The regulations say that privately owned equipment may be legally hooked up to the telephone system only after a customer gives notice to the company of the make and model of the phone, the registration number, the United Service code for the jack, and the ringer equivalence number." The ringer equivalence number—which tells how much current the bells draw—is stamped, along with the other essential numbers, on the bottom of your phone.

The FCC ruling does not allow you to do your own wiring, so if one of your rooms has no outlet you have to ask the phone company to come in and provide one, at additional cost. (Michael Baysa, of the New York Public Service Commission, says they're hoping that in the future you'll be able to do your own wiring.)

Most of the new phones come with modular plugs, which fit jacks that may already be installed in your home. If so, once you buy your phone you can take it home and plug it in as you would any other appliance. However, says Auger, "To be clear about what the rules and charges are you should call your local Bell company before you buy and install anything."

New phones aren't all that's available. You can attach many new accessories to the phones, such as call-hold buttons, phone silencers, devices that dial instantly, answering machines, tone dial converters, speaker phones, digital timers, and cost computers. You cannot legally modify any Bell equipment, but you can add attach-

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up your conversation for $399. G: General Telephone & Electronics' one-piece "Futura" simply lifts up to provide a dial tone. Place the phone down to disconnect the call. Its miniaturized components include a buzzer to signal incoming calls. Price: $79.95.

ments to your *own* phone. (Remember, it wasn't too long ago that Bell said you couldn't legally put a plastic cover on your own phone directory.) If you should decide to risk adding a gadget to your phone and anything goes wrong (such as fouling up a phone line or damaging equipment), Bell claims you'll have to pay for the damage.

But is owning your phone right for you? The big disadvantage, according to the phone company, is repairs. Lou Burke of AT&T asks, "Do you want to take on mainte-

[*Continued on page 150*]

WHO MAKES 'EM

Allied Telecommunication Equipment Co., 206 W. 40th St., N.Y., NY 10018; **AT&T,** 195 Broadway, N.Y., NY 10007; **Buscom Systems, Inc.,** 1230 Mountain View—Alviso Rd., Sunnyvale, CA 94086; **Data Phone Corp.,** 2590 E. Devon Ave., Des Plaines, IL 60018; **Fracom/ Rovafone International,** 2130 W. Clybourn St., Milwaukee, WI 53233; **General Telephone & Electronics,** 400 N. Wolf Rd., Northlake, IL 60164; **ICP Marketing,** 3031 Tisch Way, Suite 750, San Jose, CA 95128; **IT&T Personal Communications,** Clark, NJ 07066; **Remco International, Inc.,** 1723 W. Howard St., Suite 101, Evanston, IL 60202; **Royce Electronics Corp.,** 1746 Levee Rd., North Kansas City, MO 64116; **Specialized Systems, Inc.,** 11558 Sorrento Valley Rd., Building 7, San Diego, CA 92121; **Technology Applications Corp.,** 560 San Antonio Rd., Spectra Suite 204, Palo Alto, CA 94306; **Telecomputer Corp.,** 211 Orr Avenue, Opelika, AL 36801; **TeleConcepts, Inc.,** 22 Culbro Drive, West Hartford, CT 06110; **Tele-Devices Corp.,** North Country Center, Plattsburgh, NY 12901; **Travel Electronics International,** 17921 Skypark Blvd., Irvine, CA 92714.

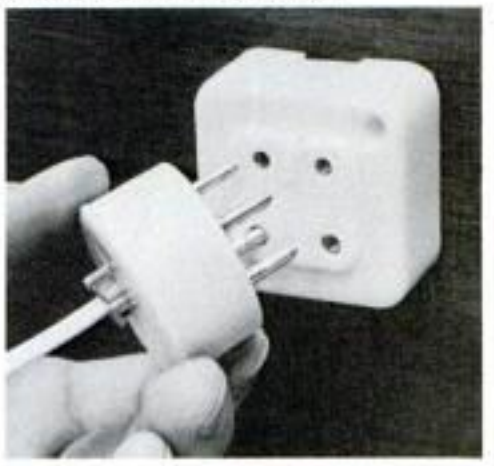
What you need to plug in

Whether you're replacing your present phone or adding a new extension, you'll need to start with a phone jack on the wall. Two types are commonly used: a four-pronged model or the newer mini snap-in type. If you don't already have one, your telephone company will install it.

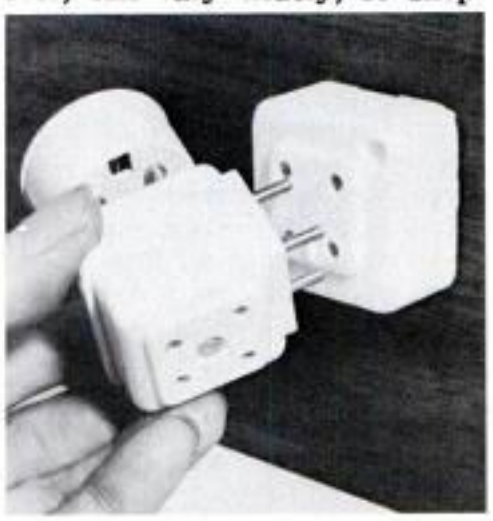
Ideally, the connector on the new phone or extension cable you buy will mate with the jack you own. If it doesn't, however, you can use an adapter block. As the photos show, various adapters are available—for mating connectors or for adding additional connectors to one jack (for an extension cable on a second phone, for example).

The connectors and wiring you'll need are available in most electronic-supply houses or telephone outlet stores. Prices, however, can vary widely, so shop around and know what you need before buying. One adapter, costing $2 in one store, can be as high as $7 in another.

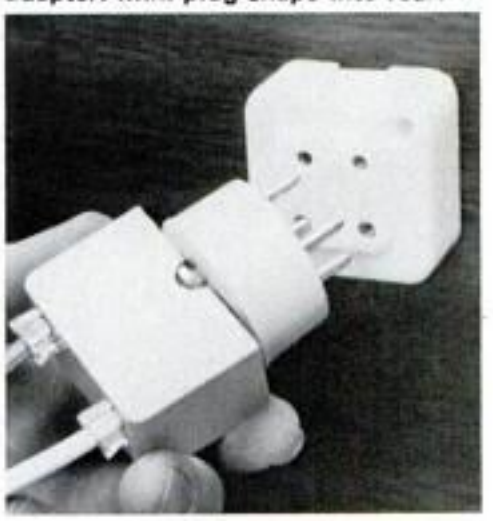
Although every installation may be different, the photos show some common adaptations you may have to make.



Conventional four-pronged jack will accept a mini-connector via a round adapter. Mini-plug snaps into rear.

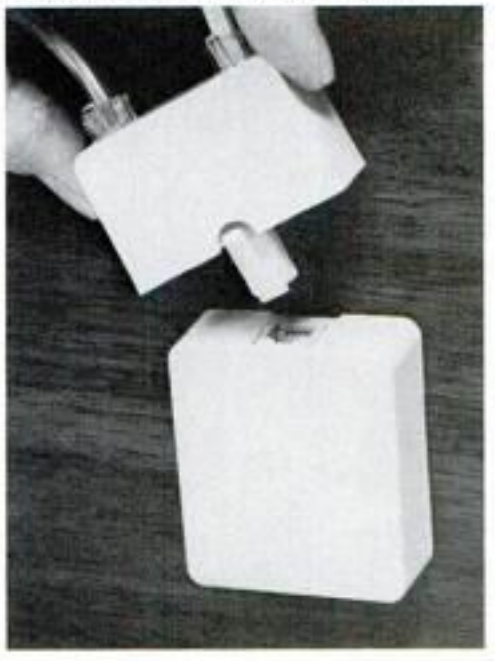


Mini extension cable can be added to four-prong system with two adapters. Mini plugs into second adapter.



Four-prong to mini plus double mini-adapter allows a new local phone and extension to use the older jack.

Short adapter cable connects a new mini-jack on the wall to an older four-prong plug on the phone.



Double mini-adapter accepts two mini-connectors (from local and extension), plugs into single mini-jack.

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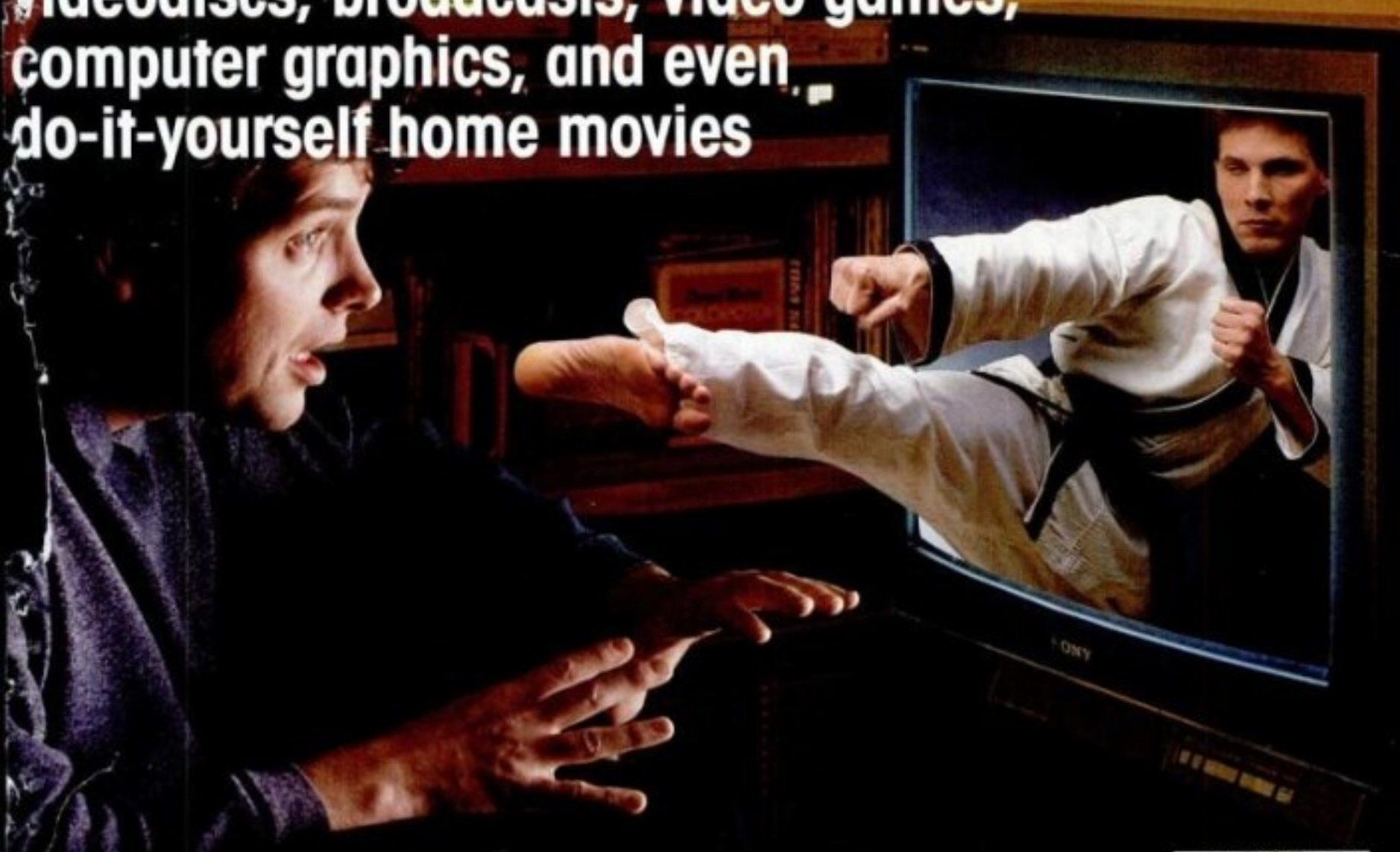
3-D TV

New for home viewing: 3-D tapes, videodiscs, broadcasts, video games, computer graphics, and even do-it-yourself home movies



Материал защищен

3-D TV

Now you can buy 3-D video games, computer software, and even a camcorder for do-it-yourself home movies in 3-D. ABC is broadcasting part of its "Moonlighting" series with the extra dimension. Get ready for gadgets that deliver 3-D from videodiscs and tapes. How good is the new hardware—and what's brewing in labs for better 3-D TV?

By JOHN FREE
Lead photo by Jim Richards

Pictures on a six-foot projection-TV screen at StereoGraphics Corp. in San Rafael, Calif., appear fuzzy at first. A ceiling-mounted projector beams bright images from a demonstration tape. Then I slip on what appear to be lightly tinted sunglasses. The screen instantly becomes a huge underwater porthole into a fantastic world of three-dimensional TV.

The screen images, videotaped in 3-D from a submersible 6,000 feet beneath the ocean surface off Bermuda last summer, become sharp and colorful. There's no eyestrain, which often accompanies 3-D viewing. Suddenly a shark noses toward the camera, seeming to lunge into the room. In another eerie scene hundreds of snakelike eels converge on a long vertical column of bait.

Such 3-D video realism, beamed from StereoGraphics' costly industrial-model hardware, is among the best available these days. But with interest in 3-D climbing to one of its periodic peaks, there's also a growing range of alternatives for home TV screens: Toshiba is introducing a camcorder for taping 3-D movies yourself, and video games and sophisticated 3-D software for personal computers are available. In Japan 3-D videodiscs have long been in stores; 3-D discs and video cassetttes may soon be sold here. The Coca-Cola Co., a sponsor of ABC's popular "Moonlighting" series, hopes to distribute 40 million pairs of 3-D glasses for an advertisement and season-ending program segment. And for budget 3-D TV, one California design firm plans to license an add-on system that could cost less than $100 for adapter, glasses, and 3-D video cassette. While each of these 3-D packages demands special viewing glasses, researchers in some labs are trying to develop 3-D TV you can watch *without* glasses.

A little background helps in understanding the newest developments. Most 3-D TV systems rely on simple binocular vision to create depth: When your eyes and brain see objects from slightly different perspectives, a sense of depth, called stereopsis, results.

The first gadget to exploit stereopsis, the mirror stereoscope, was invented in 1833 by Sir Charles Wheatstone. He created pairs of drawings, each slightly different from the other to simulate left- and right-eye views, to form a 3-D image when viewed through mirrors. Pairs of photographs and simpler mirrorless stereoscopes soon updated the original design. "In their day the stereoscope and stereo views were the equivalent of television and photojournalism," notes StereoGraphics president Lenny Lipton in his 1982 book on 3-D movies and TV.

This binocular viewing principle—a separate view for each eye—has carried over to most movie and TV systems. In the early 1920s, for example, some small theaters used film projectors that alternately beamed left and right images onto a screen. Mechanical shutters inside a viewer at your seat were electrically synchronized to the projectors, blocking your left eye when the right image appeared and vice versa. Shuttered movies couldn't deliver images rapidly enough to each eye.

Another 1920s 3-D technique, filming left and right views though red-and-blue or red-and-green filters, then viewing them through similar filters, did catch on (see drawings). But the real boom in 3-D movies began in the 1950s, two decades after Edwin Land's Polaroid Corp. made sheet polarizers available. Polarizers can filter light so it travels only in certain planes. Other polarizing filters, oriented differently, then effectively block either left or right images from the screen.

With all these techniques, why haven't 3-D movies caught on in theaters or on home TV screens? Experts I talked with blame poor attention to technical details. Proper alignment of the two stereo images is crucial to prevent eyestrain and headaches. "Stereo has gotten a bad name because of attempts by people who weren't fanatic about lining up images," explains John O. Merritt, a 3-D consultant with Interactive Technologies in Williamsburg, Mass.

"We're fairly sophisticated visually these days," adds StereoGraphics' Lipton. "It's inconceivable to me that the public will now accept flickering images or images that require you to wear red-and-blue glasses." TV broadcasts requiring colored glasses are usually disasters because colors are notoriously erratic on screens, and cheap color glasses are rarely matched to color-screen phosphors. Result: little depth, blurring, and headaches.

A relatively new technology, fast liquid-crystal (*LC*) shutters, is emerging as a solution—at least for viewing home video. The LC material is similar to that in digital wrist-

Continued

A new look for TV viewing, LC 3-D goggles help you blast weapons threatening a city in Sega's "Missile Defense" game.

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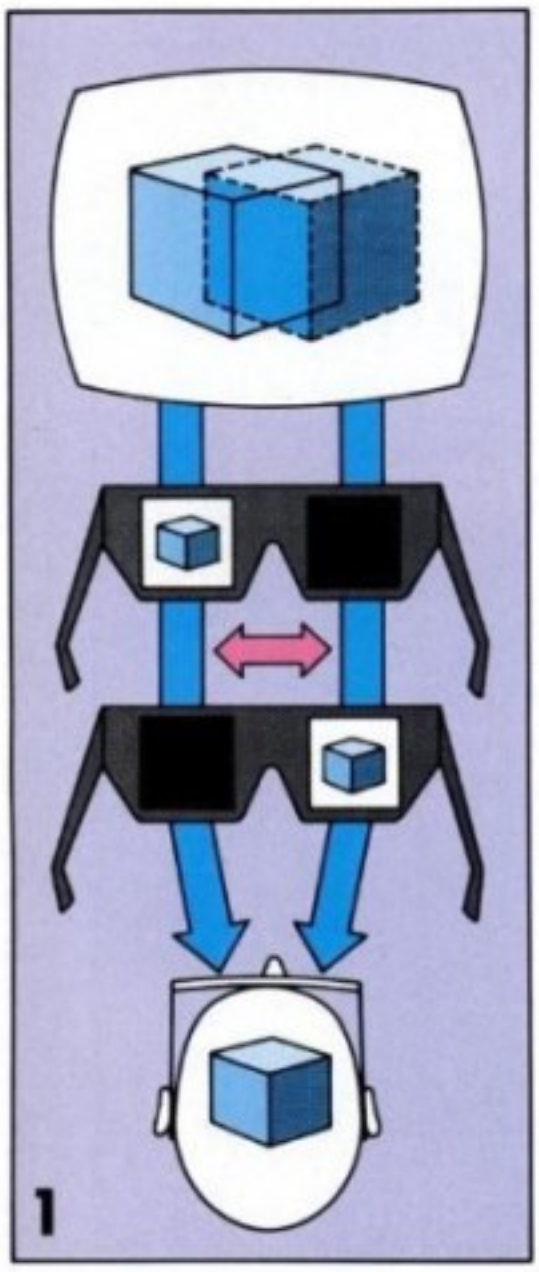
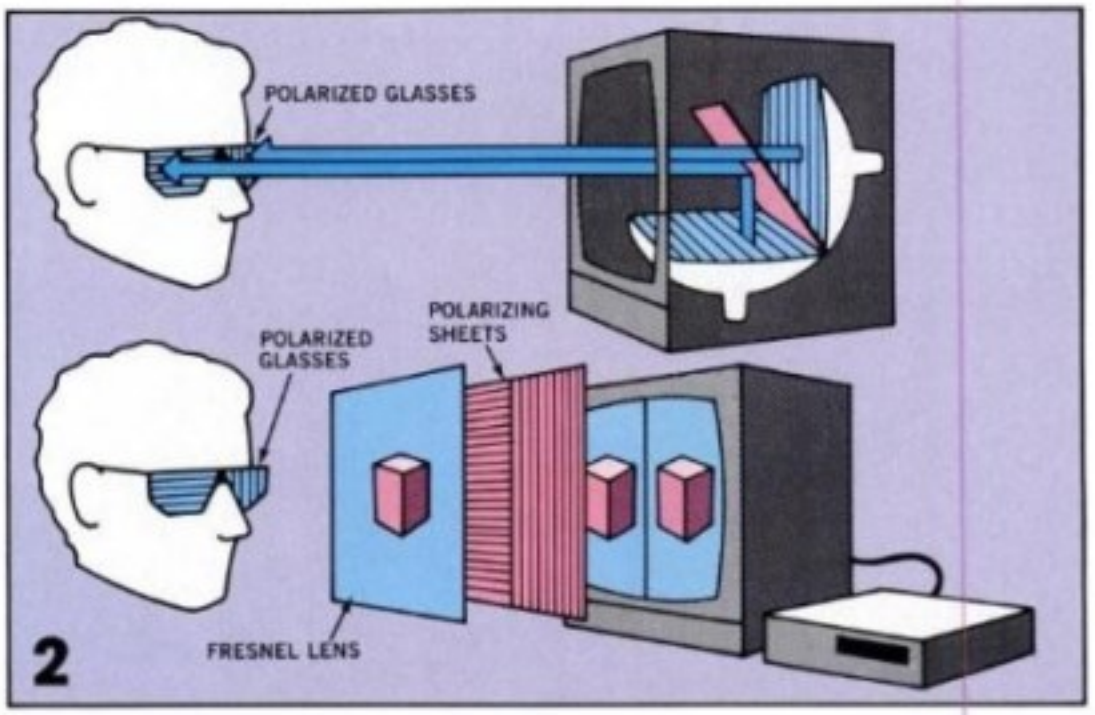
watch displays and other electronic gear. Like the mechanical shutters in 1920s movie theaters, the LC shutters can alternately block vision to your left and right eyes (see drawings). But the LC material, built into glasses, enables the left and right views to be displayed almost simultaneously—a failure of the 1920s technology.

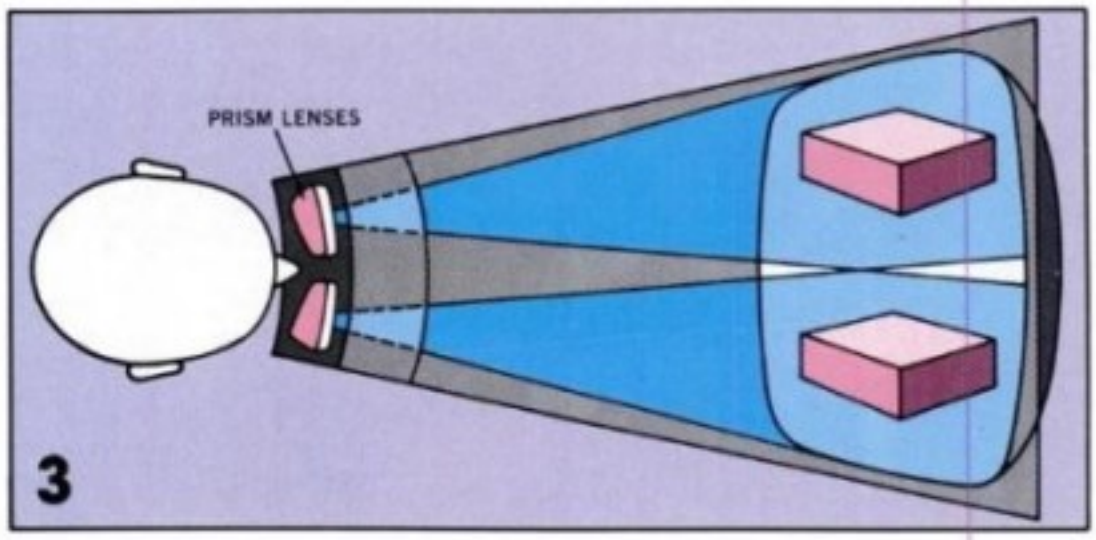
Still, LC glasses aren't trouble free. In his Glendale, Calif., lab, engineer and inventor Stephen Hines shows me a simple cure for a common 3-D problem: flicker. Hines pops a disk into his Atari 1040ST computer while I sit behind a color monitor and slip on a $99 pair of LC glasses. An amazing 3-D demonstration program dubbed "Steely Boink," goes into action. Metal-like spheres, each bearing an image of the program's creator, bounce randomly around a room, reflecting details of its interior and casting shadows on the floor. They glint yellow as they careen off a wall with the same hue. (Antic Publishing Co. in San Francisco markets the glasses and a growing variety of 3-D software.)

"Try adjusting the brightness just beneath the screen," says Hines when I complain about a slight, but irritating, flicker. Dimming the picture just slightly eliminates the problem. Flicker develops because of the switching technique used with most LC glasses: With ordinary TV both of your eyes see 60 pictures every second. Each picture, called a field, is actually half of a complete interlaced TV picture, or frame. Many new 3-D products use these 1/60-second picture fields to display images first to one eye, then the other. As a result each eye, alternately shuttered by LC glasses, receives a new picture 30 times a second instead of twice that rate. At high brightness levels, the eye-brain perceives a flicker.

Hines, a tall, slim man, built the 3-D camera assembly used for two Disney movies, and seems to be anticipating







1 Liquid-crystal shutters, worn as glasses, appear with many 3-D systems. Left and right views of scenes or objects are displayed sequentially—a split second apart—on a screen. Small electric currents, synchronized by a controller, flow through a wire connected to the LC shutters. When the view for the left eye appears on the screen, the right shutter is triggered and darkened. When the right-eye view appears, the left shutter becomes opaque. Rapid switching simulates normal binocular viewing, which creates a 3-D image in your mind. 2 Polarizing sheets and matching glasses are also commonly used for 3-D systems. In the top drawing polarizing sheets are positioned on the picture tubes. The sheets filter light from the tubes so that it travels only in thin planes that are at right angles to each other. A partially transparent mirror between the tubes superimposes the two images at the viewer's eyes. But polarized filters in the glasses ensure the image meant for the right eye is blocked by the left element, and vice versa. This dual-CRT method is too costly for consumer applications. In the lower drawing, a polarizer technique used for Bright & Morning Star's prototype 3-D is shown (see text). Stereopair images are displayed either on the two sides or the top and bottom of the screen. A polarizer sheet next to the screen has corresponding halves that filter light so the images travel in different planes. A Fresnel prism lens combines the two halves, and eyeglass polarizers filter out the appropriate images. 3 Another screen-splitting technique, sometimes used for industrial

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more 3-D films: He lifts a large mock-up of a universal dual-camera mount he's invented onto a bench. As he spins knobs and moves mechanisms back and forth, he describes how the device will enable directors to control the depth effects of 3-D images easily.

A week earlier, using Toshiba's new $2,800 camcorder, I became an amateur 3-D movie cameraman and director. This dual-lens dual-image-sensor VHS-C machine also requires LC glasses for playback and records with the so-called "field-sequential" technique ["3-D Camcorder," Jan.]. It's simple to operate. But I quickly discovered that unlike my conventional 2-D 8mm camcorder, 3-D scenes *demand* objects at varying distances to convey a good sense of depth.

Toshiba's black-box 3-D adapter, which plugs into the camcorder and your TV, has jacks for three of the big wrap-around 3-D LC goggles Toshiba provides. The goggles fit comfortably over glasses and have fairly dense filters to minimize flicker. In a bright fluorescent-lit office, with a bright TV, flicker became unbearable despite the goggle filters. But on my home projection TV in a dim setting, I scarcely noticed flicker. The sacrifice for a stomach-churning roller-coaster ride from Toshiba's 3-D demo tape: picture brightness and contrast.

Similar flicker occurred with the Sega video game I tried, which also uses LC glasses and sequentially displayed fields—like Toshiba's camcorder or 3-D software for the Atari computer. Again, low room lights and moderate set brightness cured the flicker problem as I tried to zap missiles with Sega's light-sensitive pistol (see photo). Games from both Sega and Nintendo are stored on solid-state plug-in memory cartridges.

I also tried a book-size prototype 3-D adapter from Sharp

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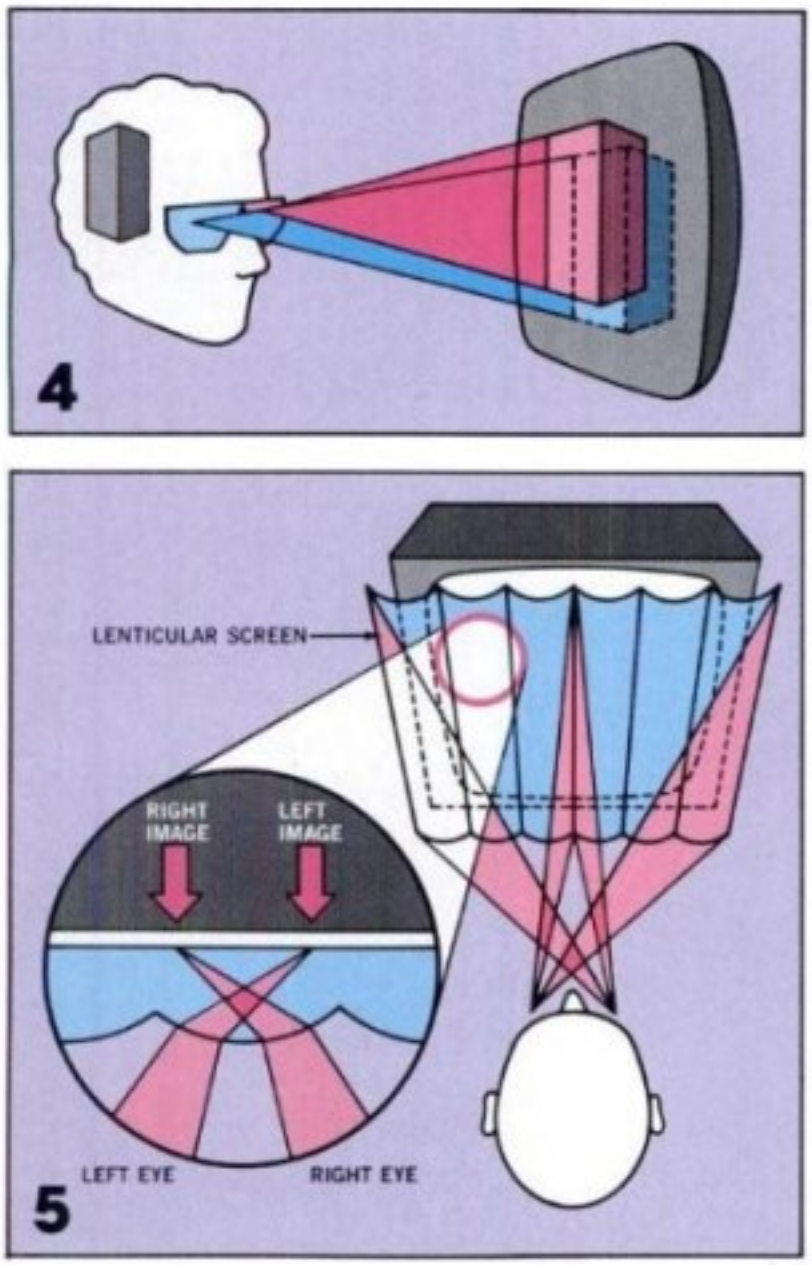
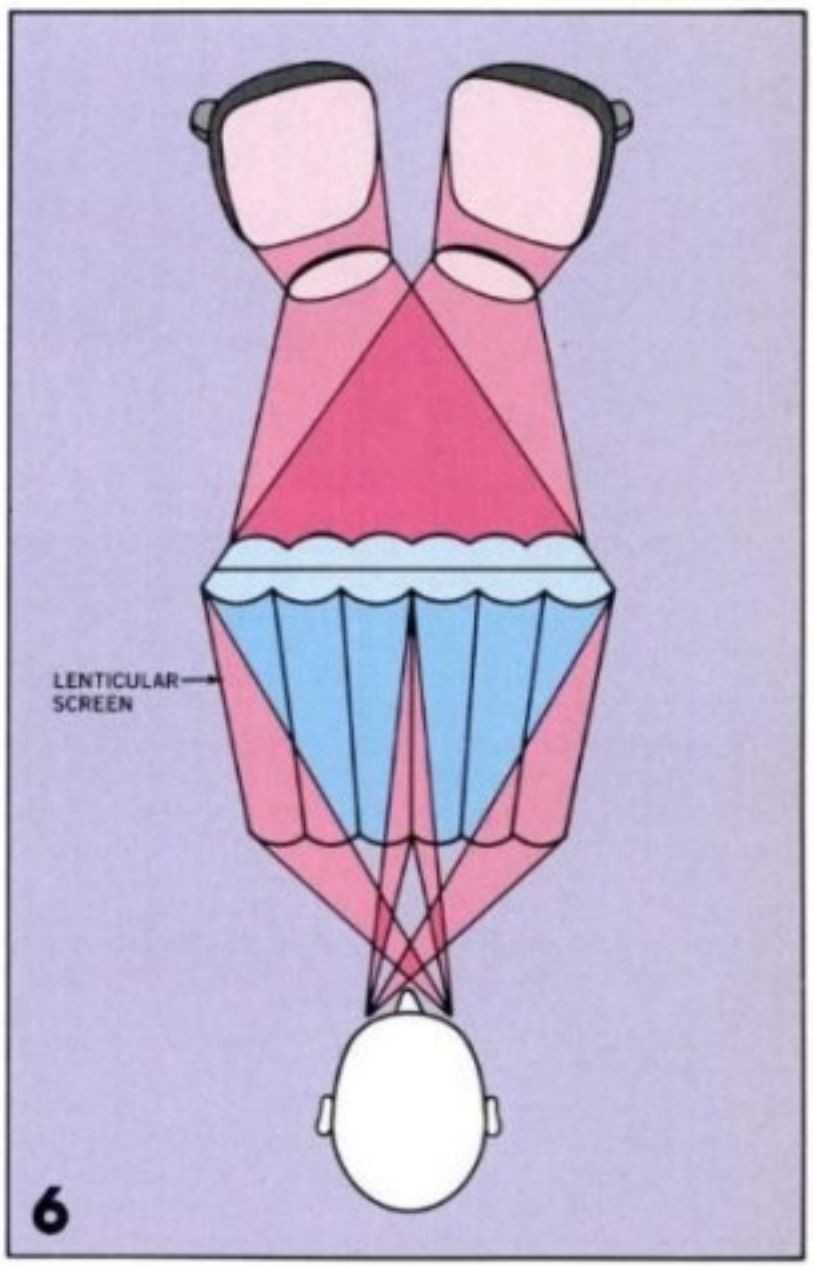
DRAWINGS BY MITCHELL J. ALBALA





3-D viewers, positions a viewing hood over the adjacent images. Prism lenses merge the image pairs for comfortable viewing. ■ A common 3-D viewing system, called the analglyph method, displays a pair of monochromatic images. The image for one eye is usually red, while the other view is green or blue. Corresponding filters in viewing glasses separate the images for the left and right eyes, because the complementary colors block each other. The color-coding technique, however, prevents true-color images from being used. Analglyph techniques create eyestrain for many viewers. ■ Single-sided lenticular screens, which have vertical strips of corduroylike lenses, are widely used for 3-D postcards and other photographic displays. These are called panoramograms. A number of vertical strips presenting slightly different views are carefully positioned behind each lenticule. Refraction of the lenticule bends pairs of left-right images on the rear of the screen into the appropriate eye (detail). Because pictures can be viewed without glasses, some laboratories are trying to apply lenticular screens to 3-D TV. A single-tube system, as shown here, limits horizontal head movement to about 1 in. to avoid mixing up left- and right-eye views. ■ Double-sided lenticular screens have also been considered for no-glasses 3-D viewing. Two projection tubes beam dual images onto the rear of one screen, while the viewer looks at the front lenticules. To make these no-glasses techniques work with lenticular screens, numerous technical problems must still be ironed out.

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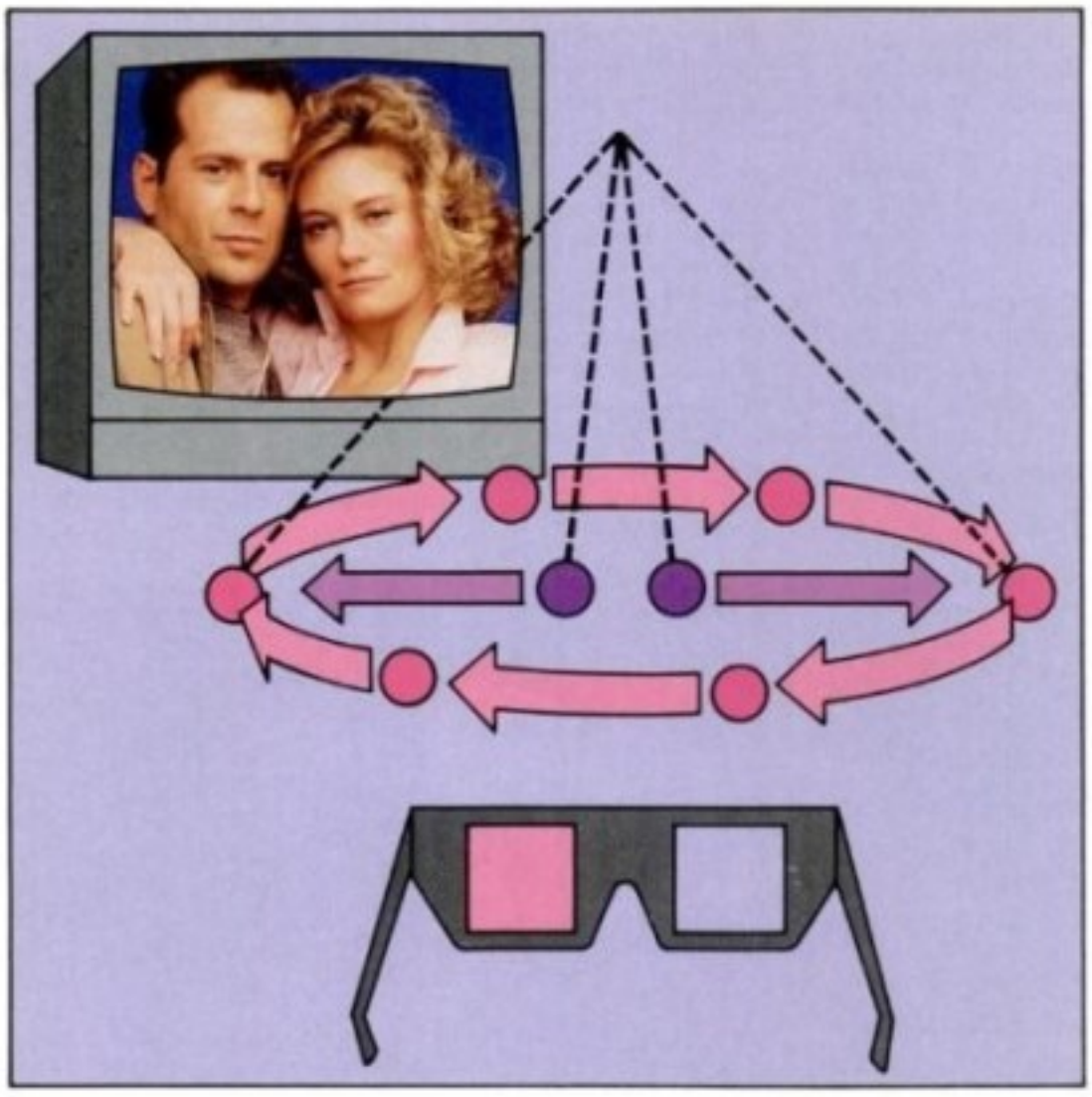

ABC's "Moonlighting" characters David and Maddie will take on a 3-D look for this season's final program—along with a Coca-Cola commercial. The 3-D technique being used is based in part on the Pulfrich pendulum effect. Swing a pendulum horizontally, and view it with a filter covering one eye. Although the effect is subtle, the pendulum appears to swing in a 3-D ellipse. For a more dramatic demonstration, view a blank noise-filled TV channel with a filter covering either eye. Horizontally scrolling stock "ticker tapes" on TV also work. Or you can tape or film scenes from a moving vehicle with ordinary equipment, then play them back with a filter over the "trailing" eye—the right eye, for example, if you've taped scenes out a right window. Below is Toshiba's new 3-D camcorder.

that plugs into any VCR. A demonstration tape delivered good 3-D pictures. While Sharp hasn't announced plans for marketing the adapter or tapes, it's likely some company will introduce a VCR adapter and software. Similarly, with renewed interest in 3-D, videodiscs are also likely to appear in this country.

StereoGraphics seems to have found the best cure for flicker. Although it too uses field-sequential recording and playback techniques, I couldn't detect flicker from any of the various displays I saw. That's because StereoGraphics' 3-D hardware all operates at twice the rate—120 hertz—of standard TVs. Lhary Meyer, vice president and technical director, tugs at his beard as he explains: "In our scheme every one of the one-sixtieth-second views has a left and a right image encoded into it. When it runs on our system there are 120 views per second. Because it's going left right, left right, you have sixty views per second per eye." The electronic encoding makes pictures—two per view—seem compressed and flattened on ordinary monitors. But the technique permits pictures to be recorded on standard VCRs, and flicker-free 3-D images appear normal during playback, despite some missing vertical detail.

The firm also performs clever tricks with polarized light so that simple lightweight glasses, without the usual electrical wire connected to them, can be worn. The single-tube overhead projector has an electrically powered polarizing system in front of its lens. This circular polarizer twists light for one field clockwise and then twists the following image field counterclockwise. StereoGraphics also installs such polarizers on CRT displays that measure up to 19 inches diagonally. Circularly polarized elements in the viewing glasses block the appropriate fields for 3-D imaging. These glasses also let you tilt your head, unlike ordinary plane-polarized lenses, which no longer block light effectively if you tilt them several degrees. The 3-D displays can also be hooked up to work with more-conventional

PHOTO BY GREG SHARKO

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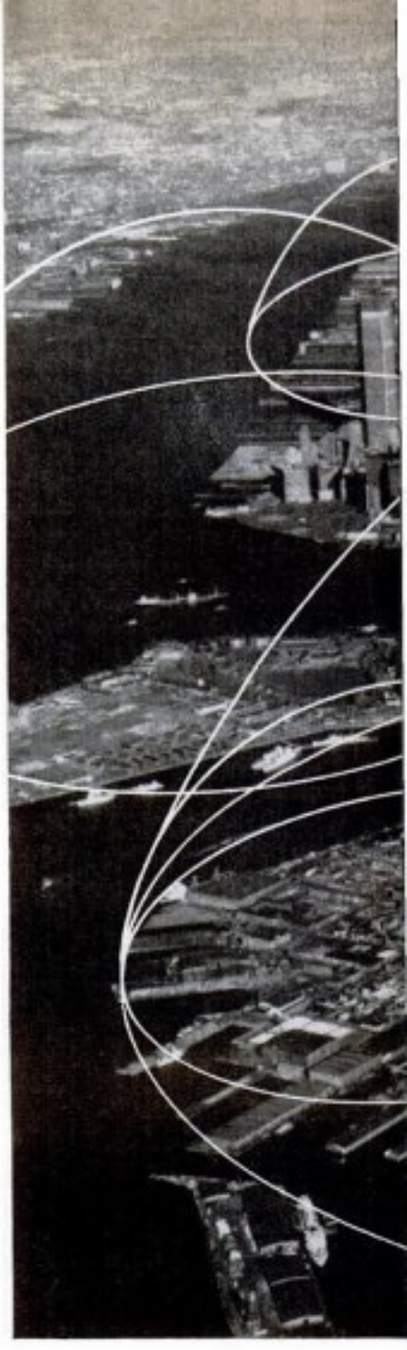
...plus 34 more exciting articles
and features—see contents on page 6

Fishing offshore, driving home from work, or riding horseback — this phone user could place and receive calls anywhere with new system planned by Motorola. Photo at right shows coverage of New York area for transmitters (large domes) and receivers (small domes) to handle calls to and from portable phones. Citywide network would funnel calls through a computerized central station. Central computer could tie portables into telephone exchange.

Photo Courtesy of N.Y. Port Authority



New Take-Along Telephones Give You Pushbutton Calling to Any Number

This amazing phone system could handle thousands of calls simultaneously, patching yours directly into a phone exchange

By JOHN R. FREE ILLUSTRATIONS BY THIBAULT/BUONOCORE STUDIOS

Minicomputer used to track and switch Dynatac calls is described to author by project engineers, right. Computer directs calls into phone exchange.

The caller pushed the portable phone's OFF-HOOK button. For a split second, the telephone—a new type of computerized, walkie-talkie-size portable—"chatted" inaudibly with a minicomputer in another building. Then I heard a familiar dial tone, and the caller tapped the pushbutton keyboard, placing a call around the world to Australia.

Motorola's Communications Division was demonstrating its Dynatac phone system in a New York Hilton penthouse suite. For each call, the portable was tied directly into a telephone exchange several blocks away over an ultra-high-frequency (uhf) radio signal. Dynatac bypasses the mobile-telephone operators required to place calls with conventional mobile and portable phones.

With Federal Communications Commission approval, the first Dynatac system may be operating in New York by 1976. Using untapped frequencies above 900 mHz, it would use a complex computer-controlled transmitter and receiver network (as in photo and drawings) for thousands of simultaneous on-the-go calls. Today's badly overcrowded radio-telephone bands (450 mHz and below) are limited to a few dozen calls at one time in major cities.

"In a city where the Dynatac system is installed," says John Mitchell, division general manager, "it will be possible to make telephone calls while riding in a taxi, walking down the city's streets, sitting in a restaurant, or anywhere else a radio signal can reach.

"We expect there'll be heavy usage by widely diverse groups—businessmen, journalists, doctors, housewives—virtually anyone who needs or wants telephone communications in areas where conventional telephones are unavailable," Mitchell said. You would not need a license to operate a portable, but would lease it from a common carrier—Motorola, a phone or radio company.

To find out how Dynatac works,

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I visited Motorola's sprawling plant near Chicago where the company produces a variety of communications gear. Martin Cooper, director of systems operations, first described the new solid-state technology required for the 45-ounce portable, then explained how the computer-controlled transmitters and receivers would function.

New uhf circuits. "Getting up to 1000 mHz is pushing everyone's state of the art," Cooper said. So far, the 900-1000-mHz uhf region has been used for point-to-point applications such as traffic-light control. Opening the band for land mobile communications, first proposed by the FCC in 1970, now requires new uhf semiconductors that will operate efficiently at low battery voltages. Manufacturers are just introducing integrated circuits with the ultrafine chip structures needed for uhf.

Using these new ICs, the portable's 14-volt battery powers the

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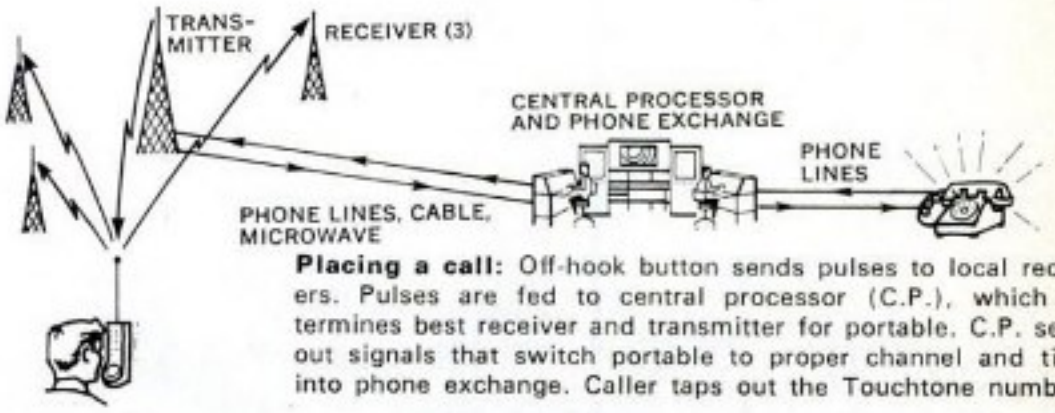
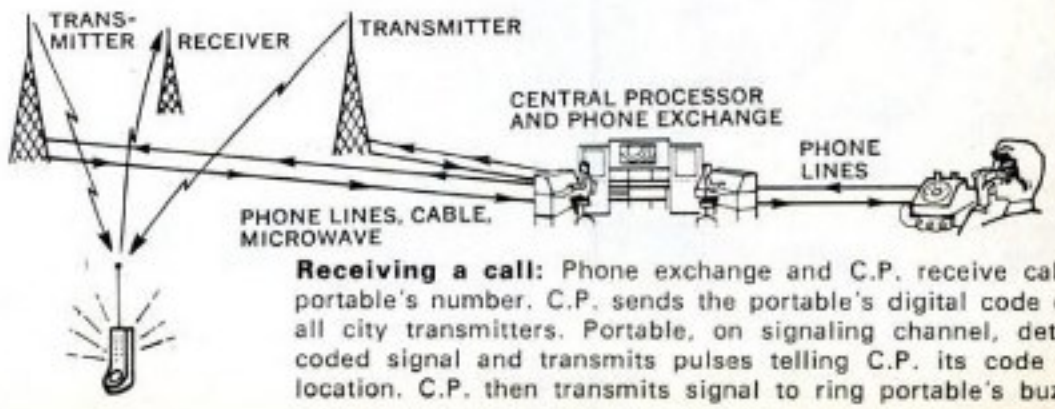


Placing a call: Off-hook button sends pulses to local receivers. Pulses are fed to central processor (C.P.), which determines best receiver and transmitter for portable. C.P. sends out signals that switch portable to proper channel and tie it into phone exchange. Caller taps out the Touchtone number.



Receiving a call: Phone exchange and C.P. receive call to portable's number. C.P. sends the portable's digital code over all city transmitters. Portable, on signaling channel, detects coded signal and transmits pulses telling C.P. its code and location. C.P. then transmits signal to ring portable's buzzer.

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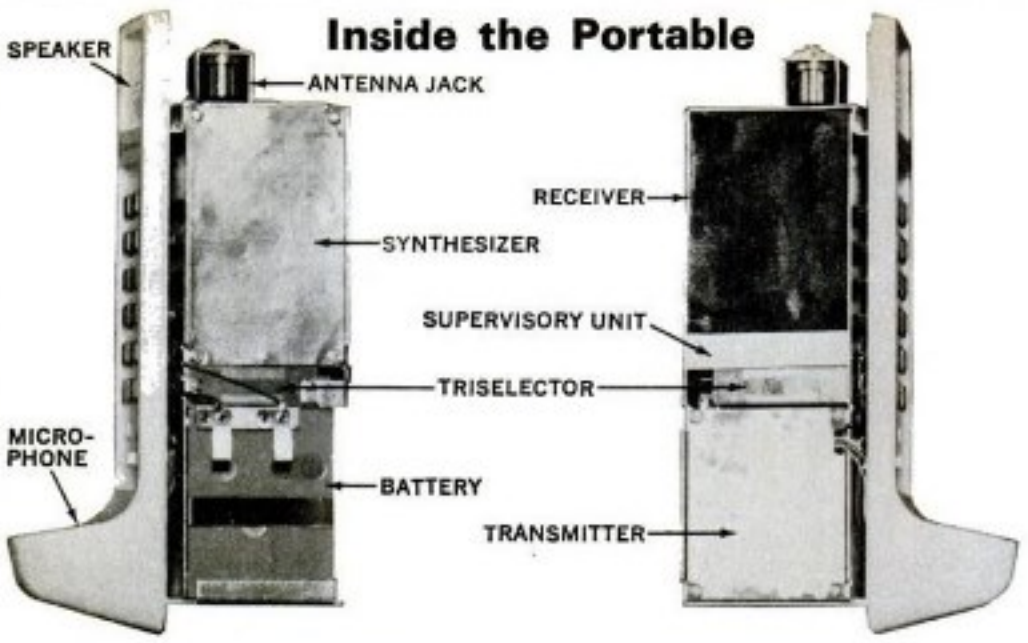
Inside the Portable



Circuits in the portable are isolated from each other by soldered sheet metal to prevent uhf interference. The eight-chip synthesizer generates 380 channels electronically. The triselector is a series of transmission lines for front-end tuned circuits and the duplex function (see text). The 14-volt ni-cad battery delivers power for 36 minutes of transmission. The two-chip supervisory section is the brain of the portable. It receives and sends digital signals to central computers. The transmitter is a one-watt custom linear IC. Squeezed into other parts of the chassis: Touchtone, AOC and VOX (see text), ringing and display circuits. The unit measures 1⅞ by 3½ by 9 in. and weighs 45 ounces. The flexible antenna is cut for the 900-mHz uhf band. Antenna gain is superior to quarter-wave whip designs.

one-watt uhf transmitter for 12 three-minute calls, and provides 12 hours of standby reception for incoming calls.

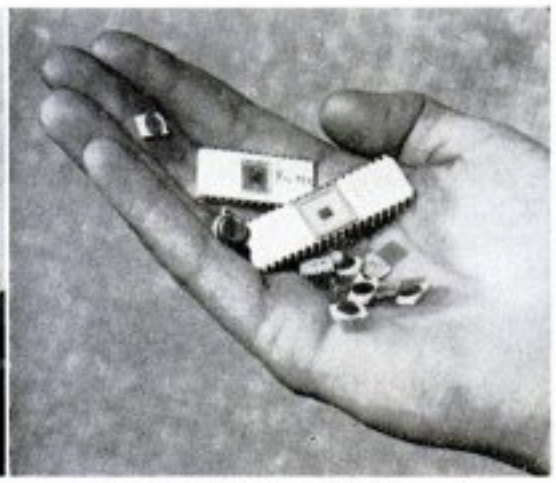
FM communication over Dynatac is duplex with VOX (voice-operated transmission). Duplex means you can talk and listen at the same time, in contrast to press-to-talk mikes on private-dispatch and military radios. When you transmit, an LED (light-emitting diode) on the portable glows.

Most of the portable's complex circuitry is used to generate 380 transmission channels and "talk" in binary computer language with central-processor computers. Fourteen LSI (large-scale integration) circuits, containing some 3000 transistors, are used for these functions.

Urban areas where Dynatac will be used are notorious for severe RF interference from vehicles, fluorescent lighting, and other sources. "We have to be concerned about an ignition pulse knocking out a bunch of data," says Cooper. "What you're looking for is the optimum way of plowing through this interference."

The electronic chitchat between the portable and central processor, which goes on inaudibly even while you're talking, is relatively immune to interference. The key is redundancy—extra bits of digital information beamed over the air. Losing some bits won't destroy a message.

Motorola's Martin Cooper, left, outlines proposed coverage of New York by radiophone system that may be in use by '76. System can handle thousands of calls.



Handful of 14 digital LSI packages used in prototype portable contains some 3000 transistors. Most LSI chips were specially designed for the portable.

Here's how the transmitter and receiver network would be set up: Transmitters, each surrounded by several receivers, would be strategically located throughout a city. The range of each 16-watt transmitter will correspond to the area's population density and expected phone use by subscribers.

Coverage and population. In super-dense Manhattan, for example, a transmitter and its antenna may be designed to cover a 15-block area. Another transmitter in a residential Brooklyn area may cover several miles. As the number of subscribers grows, more transmitters would be added. The range of existing transmitters would then have to be reduced. Numerous receivers are required because the portable's output is low (one watt).

Although Dynatac would use only 380 channels, through *geographic reuse* thousands of simultaneous calls and some 200,000 subscribers are possible (not everyone telephones at once). This means a caller in one part of the city would be using one channel while others use the same channel in nearby areas.

To avoid interference, the central processor would assign the same frequency to every third transmitter. A channel might be used simultaneously by 40 callers in later, high-density stages of Dynatac.

To understand how the portable operates with the central processor, let's trace a call from start to finish:

Making your call. When you push the OFF-HOOK button the portable is sitting on a signaling channel. The portable's supervisory section (see photos) sends a stream of digital data from the transmitter.

Several nearby receivers pick up the data, and send it by telephone wire, microwave, or cable to the central-processor station. There, minicomputers sense which signal is strongest and select the best receiver and transmitter for your call. A burst of data from the central processor is beamed from a nearby transmitter to your portable.

This data tells the supervisory section which talking channel the synthesizer section should electronically generate. Now the central processor ties you into a telephone exchange and you hear a dial tone. The portable is then used like a cradle pushbutton telephone.

"We'll probably have several sites near telephone exchanges with a trunk going in; one pair of wires for every customer," says Cooper.

If you travel through the city while telephoning, the central processor will sense changes in your

[*Continued on page 130*]

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Flat-screen TV, nine-picture digital TV, 35-inch tube, and more about

super-TVs

Hang your next TV on a wall like a picture. Check—or watch—up to nine TV shows at once. See images with twice the normal resolution, and never see snow, smears, or ghosts. Those are just some of the promises of the new sets slated for introduction soon.

By DAVID LACHENBRUCH

TSUKUBA, JAPAN

To my left is the NEC pavilion. It's topped by a parabolic satellite antenna spanning an incredible 150 feet in diameter. Inside the building you can try the world's biggest video game, played on 108 computers attached to 27 super-size 133-inch projection screens. To my right is Matsushita's exhibit. It features a video show that's displayed on three side-by-side LCD panels, which form the equivalent of a 220-inch color-TV screen. And above everything else—in view of thousands of people at one time—is Sony's Jumbotron TV ["Science Newsfront," PS, May]. Its screen measures diagonally half a football field.

This was Tsukuba Expo '85, my starting point for a journey that would take me to the major TV manufacturers throughout Japan and the U.S. The show emphasized today's incredible revolution in television. Never before have there been so many exciting new developments, available now or just ready to be introduced. For example:

- A hang-on-the-wall TV set promised for next year could be less than an inch deep, with all the electronics contained in its picture frame.
- The super-efficient beam-indexing tube—a long-sought alternative to the standard shadow-mask tube—is available in two different products, and will be marketed in a new flat version this fall. It just might revolutionize the color tube.
- Picture tubes are getting larger. The picture quality of direct on-screen viewing is now available in screen sizes previously limited to projection TV.
- Digital TV sets are finally ready. You can buy sets now that can put two pictures on the screen in different sizes and positions. Just months away are sets that let

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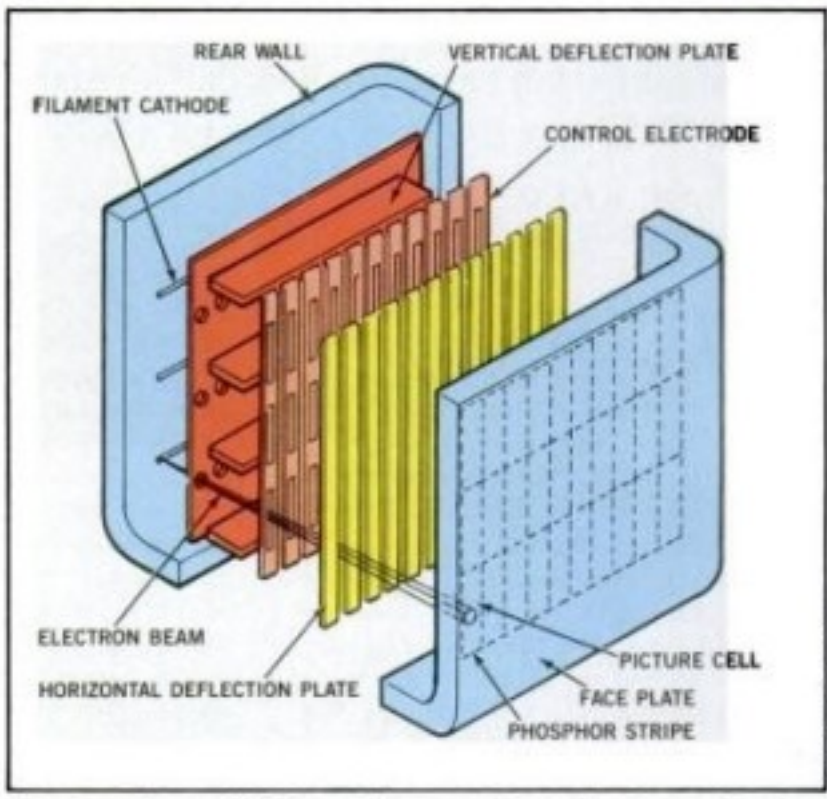

Hang-on-the-wall TV could come from the flat tube Matsushita (Panasonic's parent company) used in its prototype portable (top photo). Tube consists of 3,000 picture cells in a 200-by-15 matrix (drawing). Each cell is scanned by its own electron beam, formed by filament cathodes intersected by electron-beam control electrodes. A microprocessor positions each beam, eliminating the shadow mask.

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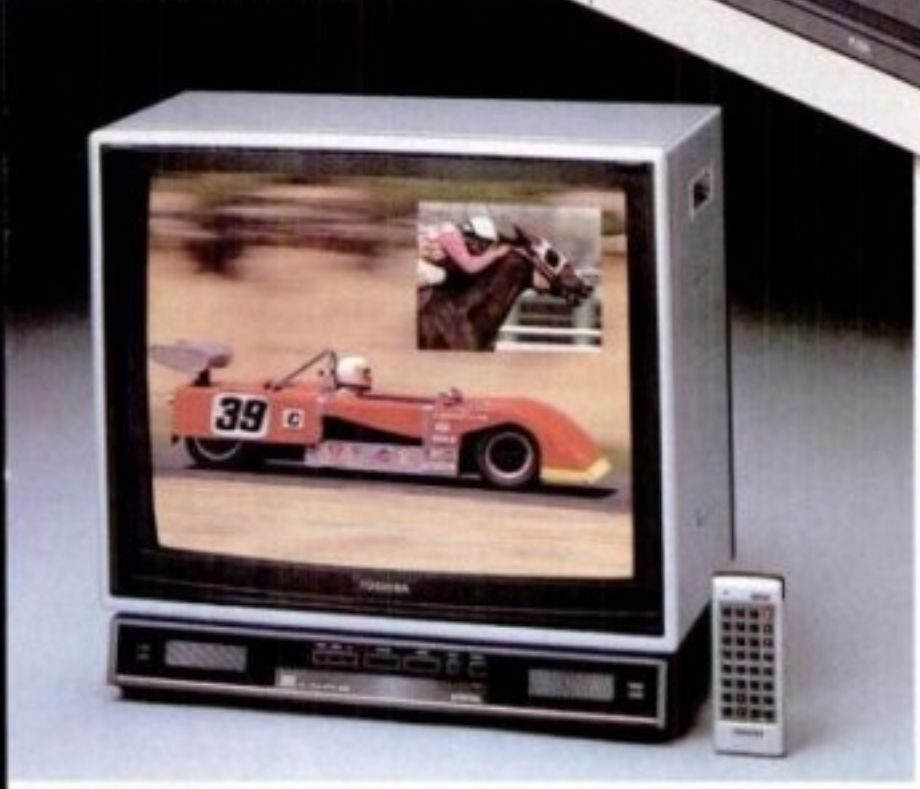
SCREEN PICTURES SIMULATED

Up to nine images are simultaneously displayed on Mitsubishi's M-PIP TV set. Pictures come from a single digital tuner that sequentially scans channels you've selected.



Picture-in-picture (PIP) digital TV from Toshiba displays two scenes at once. Main picture comes from TV's tuner; second from video source like a VCR.

Standard 525-line picture at right becomes 1,050-line display at far right after processing by Sony's scan converter. Converter doubles the number of lines by averaging two adjacent lines and using the figure for a third between them. The normal scanning system changes to progressive scan.

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Lollipop tube from Sanyo uses beam indexing to create color images. Bottom electron gun and the lack of a shadow mask allow the tube to be used in a set just 1.7 in. deep.

you sample up to *nine* different TV channels on the same screen at the same time.

• High-resolution pictures, by means of a digital component called a scan converter, can now be derived from standard 525-line broadcasts and video cassettes.

With all these changes, none is more obvious than picture-tube design. And none is more dramatic than what I saw at my first stop, the Matsushita pavilion.

Hang-on-the-wall?

"All research-and-development work is completed on these," said Yancy Fukugawa, overseas marketing director for Matsushita and my guide at the pavilion.

I looked closer as I passed a series of three little brightly lighted TV screens. Each was portable-size, with a normal-appearing 10-inch picture, and at first glance nothing out of the ordinary. But then I did a double-take: Each set was a compact package less than four inches deep—about the size and shape of an attaché case.

The display is enclosed in a glass envelope from which the air has been evacuated (see drawing). But this "tube" is almost completely flat, about the size of a 500-sheet box of typing paper, and without the cathode-ray tube's traditional neck or stem.

Because each picture cell has its own electron beam directly behind it, the new tube doesn't suffer from geometric distortions (pincushioning) or from focus problems, which are caused by the wide angle the electron beam must travel in a conventional tube. The tube is virtually distortion-free, making it ideal for such graphic media as videotex and high-definition TV.

Although 10 inches isn't very large for TV viewing, there's virtually no practical limitation in size, Fukugawa told me. Later he proved the point at a private demonstration in the Matsushita research labs. There I was shown another version measuring 15 inches diagonally. The prototype flat panel I saw has a horizontal resolution of 270 lines, or two lines per millimeter—about the same as a conventional picture tube. Its contrast ratio is given as "more than 50," and brightness is more than 70 foot-lamberts. The best picture tubes have a contrast ratio of approximately 100 and at least 100 foot-lamberts of brightness, so the flat display must be improved to provide a picture the equivalent of a standard cathode-ray tube (CRT)—at least in numbers. As I viewed the tube, however, it didn't appear to be wanting in either brightness or contrast.

Could this become the long-sought 25- to 30-inch picture-on-the-wall TV POPULAR SCIENCE prophesied in March 1975? Maybe. But Matsushita officials can't be persuaded even to guess when it will go into production, in what screen sizes it will appear, or what the price might be.

Another approach to flat color-TV pictures is the familiar liquid-crystal display (LCD) used in digital watches, calculators, and pocket LCD TV sets [PS, Nov. '83]. Just a little more than a year ago it was generally believed that their practical size limitation was about four inches. Now, however, they're being groomed as candidates for picture-on-the-wall displays.

At the 1984 Japan Electronics Show, Casio demonstrated a wall-hanging flat LCD color TV with a six-inch screen. Although it lacked the warmth and glow of a CRT picture, the backlit display was eminently viewable. Since then, Casio's officials have become very quiet about plans for a wall-hanging set. But reports leaking from the company's labs in Japan indicate that the goal for the first such color set isn't six inches at all—but 12, with a depth of an inch or less and possibly with all the electronics built into the frame. It's targeted to include picture quality equal to that of a CRT at a price of $400 in Japan (about $500 here).

Apples and lollipops

Another approach to TV displays involves a concept developed more than 30 years ago by Philco under the code name "apple." The technical name of the apple is the beam-indexing tube, and because of its design complexity, only recently has it been put to use.

A beam-indexing tube eliminates the metallic shadow mask used in conventional tubes to direct electrons from the three guns to the correct screen phosphors. Instead, it uses an additional stripe—an index—alongside each group of color-emitting phosphors on the screen, and a single electron gun. As the electron beam sweeps the screen, the indexes are detected (by a photodiode), providing beam-position information to the electronics. The beam is then switched on or off at the appropriate time to excite the wanted color phosphor. Because there's no shadow mask to absorb electrons, the tube can produce extremely bright pictures at conventional power levels, or it can produce acceptable pictures at very low amounts of power. How it is used depends on the application.

The first commercial use of a beam-indexing tube came in 1983, with Hitachi's 1½-inch low-power version for the first color viewfinders in consumer video cameras. And Sony uses a high-power version in its Indextron commercial projection TV. More recently Sanyo has used it to create the "lollipop."

"There's another big advantage in beam indexing," said a spokesman for Sanyo. "Without the shadow mask, which must be at a critical distance between the electron guns and the face plate, the tube can be squashed flat. We found that beam indexing provides the ideal way to add color to flat tubes without the customary bulk."

Also, instead of a neck that extends from the back of the tube, the Sanyo tubes have necks that extend downward in about the same plane as the tube's face (see photo). As a result, the tube resembles a lollipop. The first use is in a bright color set only 1.7 inches thick, with a three-

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Now—a REALLY big show!

A 4′-by-6′ Color TV Picture

Since the beginning of TV, companies have been trying to develop big-screen television for home use. Now there's one you can buy—and others are under development

By C. P. GILMORE
PHOTOS BY ORLANDO GUERRA

The projector's control panel will be concealed by a small door in the production model. Controls are the same as those on conventional sets, except for three convergence controls (see text). The set is designed for serviceability: Power supply is at the bottom; other electronics are on plug-in circuit boards on swing-out chassis.

CAMBRIDGE, MASS.

There on the wall was the bigger-than-life image of a smiling President Nixon getting off Air Force I in Poland and shaking hands with officials. It looked like a clean, sharp movie, only brighter.

But it wasn't a movie. What I saw was happening at that moment. The President was live and in color on a startling new giant-size color projection-TV system—the first designed for home use. The unit—the one you see photographed on these pages—was a laboratory prototype. But the commercial model will be on the market about the time you read this.

The six-foot-wide picture—12 times the size of the biggest (25-inch) direct-view set made—is big enough for a small auditorium. But in your living room, a few feet from your favorite viewing chair, it delivers qualities that can't be rivaled by the small screen. Impact. And sharpness. And clarity. It's better in these departments than anything available on the market.

Now for the bad news. The unit will sell for $2500. Later models will be cheaper. How much cheaper and how soon it will arrive are unknown.

Of course projection sets aren't new. Special sporting events such as championship fights are shown in movie theaters with a device known as the Ediphor projection system. It costs a hundred and thirty thousand dollars. General Electric has a projection system for classroom and industrial use. It runs $39,000.

The new home model, ridiculously cheap by previous projection-TV standards, was developed not by one of the big TV makers, but by the Advent Corp., a firm known until now for its work in the high-fidelity field. Prime mover is Advent's president, audio pioneer Henry Kloss.

How it works. The unit contains three projection tubes—one for the red image, one for blue, a third for green. Three color images are projected separately to the screen, where they combine for the full-color image.

The picture is not only big, it's super-sharp. In a conventional shadow-mask tube—the kind in most present TV sets—each individual picture element on the tube face is made up of a "triad," three color dots that blend to produce one final spot of color. Image sharpness is limited by the relatively large size of the color triad. The projection tube has no shadow mask, hence no such sharpness limitation.

Result: sharpness even better than that obtainable on an expensive stu-

The other systems—promising, but there are still problems

At least two other big-screen projection-TV systems are under development. Sony demonstrated one early this year [Look and Listen, PS, May]. To my eye, the picture is excellent. But brightness is a problem. The device, with a 12-inch extra-bright Trinitron as the picture source, projects the image through a five-inch lens onto a 2.5-by-3.3-foot screen. Image brightness is about three footlamberts—about like an 8mm home movie. To get a good picture, it must be viewed in near darkness. The Sony unit (including receiver) will sell for about $2500.

I recently saw another fascinating system in Los Angeles—by far the most sophisticated one I've heard of. Developed by Dr. Theodore Maiman, who built the world's first laser in 1960, the system predictably uses a laser as the light source. The laser oscillates at three different wavelengths, producing a beam containing red, blue, and green light simultaneously.

The secret of Dr. Maiman's system lies in two advanced devices he will not discuss at present. One is a solid-state, nonmechanical unit that sweeps the laser beam through the usual TV raster across and down the screen. The other simultaneously but independently modulates each wavelength so the precise amounts of red, green, and blue light are delivered to each point on the screen to produce a balanced color picture.

Performance is impressive. The picture I saw was not bright enough, but Dr. Maiman says optimizing the optical system will increase brightness by a factor of 10—plenty bright enough.

The unit I saw had a three-by-four-foot screen and was 30 inches deep. It is a rear-projection machine with internal mirrors that fold the beam and conserve space. Dr. Maiman also showed me a mock-up: same screen size, but only *nine inches deep*, hanging on a wall like a picture. He has already worked out the technique for folding the beam into this package.

Dr. Maiman's company hopes to have a 30-inch-deep commercial model on the market in about a year. Primarily for institutional use, it will cost between $8000 and $12,000. A year later, the nine-inch-deep home version will be available for $2600. Price should eventually drop to about $1200.

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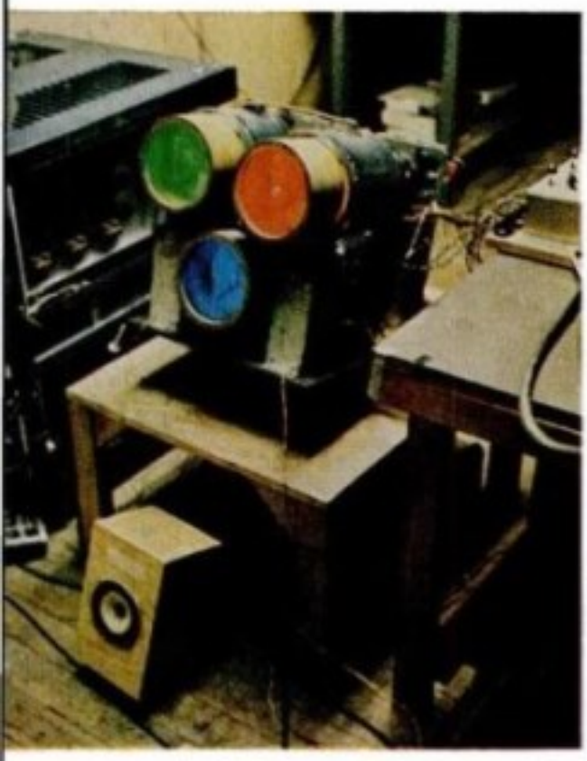
on Your Living-Room Wall



Heart of projection system is this triad of color tubes, one each for red, blue, and green images. A small acoustic-suspension speaker, flat from 80-12,000 Hz., projects sound toward the screen, from which it is reflected. At right, inventor Kloss adjusts prototype. Comparison picture can be seen on studio monitor at bottom right.

dio monitor—the kind networks use to check their signals. Kloss had such a monitor set up for comparison. When a test pattern came on, I could see finer detail on the projection screen. The set has an inherent 1000-line resolving power, which means it can produce twice as much detail as our present 525-line TV system.

Sharpness is just the beginning. "The entry fee on projection television is brightness," says Kloss. "Until now it has never been paid in a home system." Screen brightness of the new Advent system is over 15 footlamberts. In practical terms, the set might be viewed in normal room lighting; in moderately subdued lighting of the kind you find in many living rooms, the picture is brilliant.

Brightness grows out of the projection principle used. The face of any TV tube glows when a beam of electrons hits its face. The more electrons (the greater the beam current), the brighter the picture.

One big trouble with the conventional shadow-mask tube is that the shadow mask itself interrupts the beam a lot of the time as it plays back and forth across the tube face, thus sharply limiting the number of electrons that get through to the phosphor coating to produce the picture.

The Advent projection-tube phosphors, on the other hand, work 100 percent of the time. Thus they crank out some five times as much total light as a conventional tube.

When this light is projected on a screen, about two-thirds is lost through the optical system. But a screen of highly reflective aluminum gives a gain of 10 (the image reflected from it is 10 times brighter than the same image projected on a plain white surface). The net result of all this arithmetic is a picture not as bright as the one that you see on a conventional set, but still bright enough, even though it covers 10 times as much area.

Design tricks cut costs. Projection tubes similar in principle to the Advent version have been built before. But they cost thousands of dollars per tube. Clever manufacturing tech-

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niques cut the cost at Advent to a fraction of that figure.

To produce an undistorted image, the reflecting mirror in the tube should be parabolic in shape. But a parabolic mirror is very expensive, and must be ground and figured—or corrected—by hand. A spherical mirror, on the other hand, can be made cheaply by an automatic machine.

In the early 1930s, a German optician named Bernard Schmidt figured out how to make a cheap spherical mirror do the job of an expensive parabolic one. He designed a corrector lens to go in front of the mirror that predistorted the light in such a way that it exactly canceled out the distortion introduced by the spherical surface. The Schmidt telescope quickly became widely used by astronomers and today is still one of the most popular astronomical instruments.

Advent used a computer to calculate the shape of the corrector lens needed to go with a Schmidt projection system of the necessary size, then had a high-precision machine shop grind out a steel blank to this shape. The blank became a mold.

In production, a technician puts acrylic powder into the mold, heats

TV projection tube—a cross between a TV set and an astronomical telescope

Electron beam leaves the gun at left and travels to the target. Deflection coils around the neck (not shown) create TV raster pattern. Beam strikes the 2½-inch-wide phosphor-coated target, creating the TV image. Light thus generated is reflected by the spherical mirror out through the front of the tube. There, distortion introduced by the spherical mirror (see text) is canceled out by a special corrector lens, which is mounted in a plastic bracket and slipped on to the front of the tube. The small target size means that beam deflection is only 15 degrees, making for extreme linearity of picture.

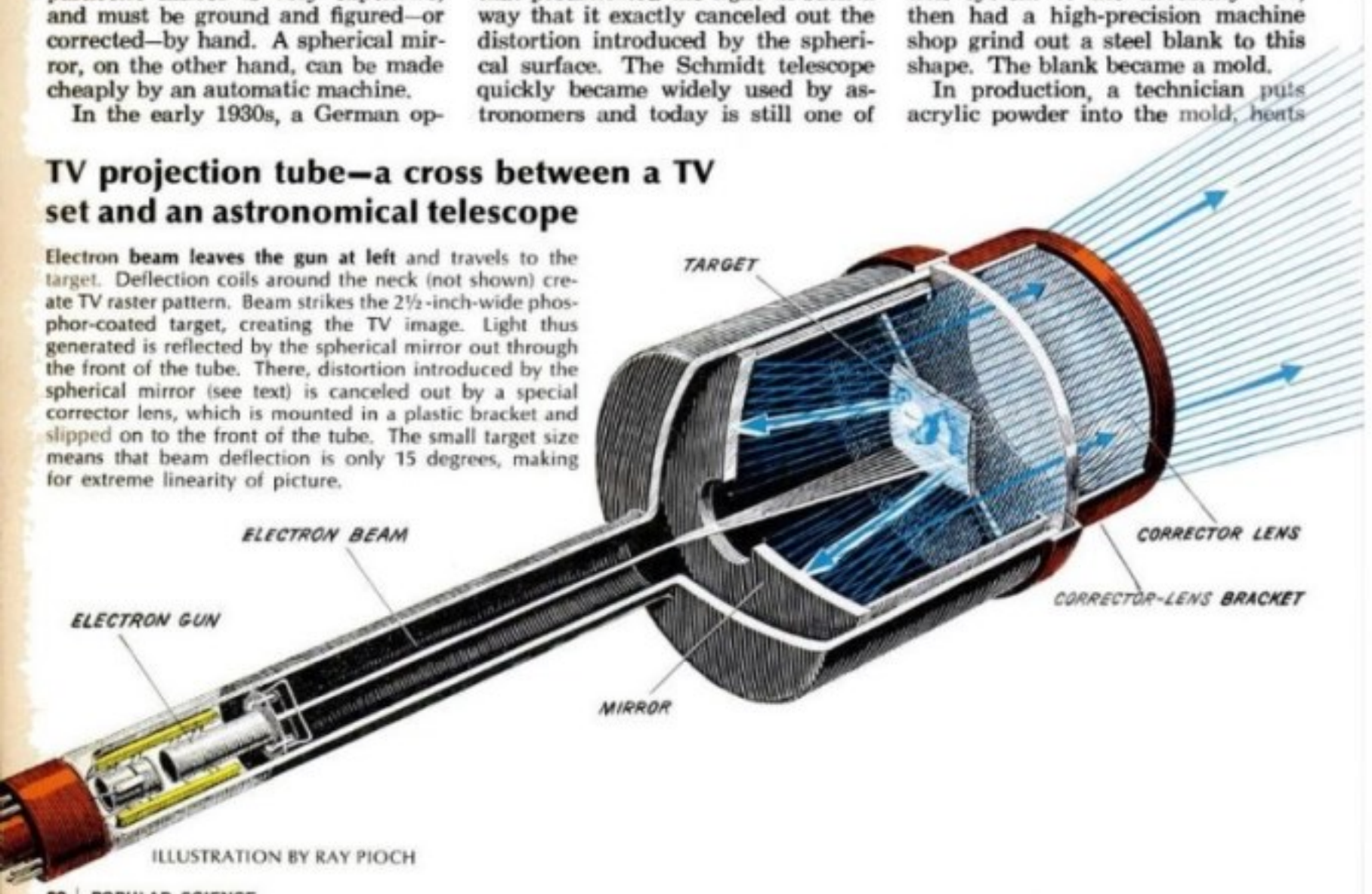

ILLUSTRATION BY RAY PIOCH

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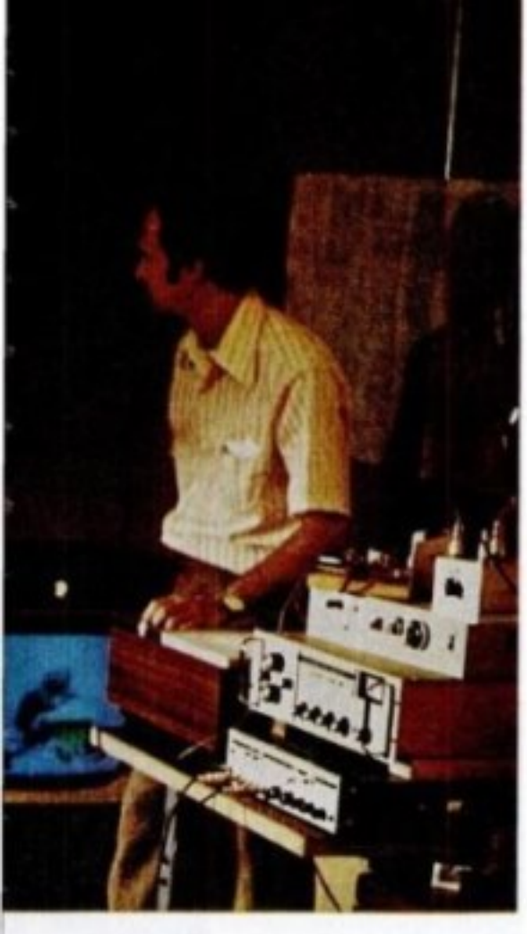

Three laboratory units simultaneously produce picture, color bars, crosshatch pattern

Projection screens are made in this special jig. A sheet of a special highly reflective aluminum foil is pulled across lower part of jig, and the top is lowered by chains. Air pressure blows the aluminum into a perfect spherical section of exactly the proper radius. A form of precisely the same curvature rises from below to support the fragile aluminum, and a plastic foam that hardens into a rigid material is poured on top of the bubble to produce a light, rigid, highly reflective screen for sharp pictures.

it, applies pressure, and cools it. Unlike normal plastic injection molding, it's a slow technique, but it produces a precise lens that doesn't shrink or distort. And it's cheap.

Kloss's general philosophy also helps to reduce costs drastically. "This is a single-purpose device built to do one thing well and nothing else," he says. "The picture size is fixed. The position of the projector is fixed. All of the optical elements are precisely made and then adjusted and locked into position. Nothing can get out of adjustment. All of this cuts cost."

Since it bypasses the whole complex shadow-mask principle, the Advent set doesn't have the usual complex convergence controls used to align the three color images. But it does need convergence of a kind. Since each tube projects its image from a slightly different angle, each projects a trapezoid on the screen instead of a perfect rectangle.

To correct for this distortion, special circuits have been built into the projection system. The controls are on top of the set, easy to get at. To make an adjustment, the user punches a button that puts a crosshatch pattern on the screen. Then he adjusts the three controls until all are perfectly aligned.

Drawbacks? Other than price, only one important one that I could find: Contrast is not so great as it is on a direct-view tube. I didn't notice it at first, but spotted the difference in careful comparison with the studio monitor. The problem is inherent: The screen reflects some room light, so blacks aren't as black as they could be. But I don't think you'd notice it without a comparison. And for full contrast, you can turn off the room lights.

What's ahead? When the Advent projection TV first appears on the market, it will be available in one form at one price. Price should come down as engineers find cheaper ways.

For example, they could probably make the projection tubes smaller. And given time to develop it, they could use electrostatic instead of the far more expensive magnetic focusing. Many such refinements could be made. "Given time," says Kloss, "we can undoubtedly design more-sophisticated optics, work the phosphors harder, make the tubes smaller, find cheaper ways to do things without sacrificing quality."

Kloss is thinking of other versions, too. A ceiling-mounted projector would eliminate the console in the middle of the floor, as would an all-in-one rear-projection model. If the present version is successful, these could follow later. ■

The Advent tube is quite different from normal TV tubes, so the company manufactures the tube, as well as many components not readily available on the market. At left: Tubes are placed in vacuum equipment that will pump air out. Vacuum equipment can be seen beneath the work surface; box at top is an oven that will lower to heat tubes during pumpdown. Center: Whirling flames preheat the neck of the tube before sealing. Right: A corrector lens in its bracket is slipped over a tube.

The WHAT'S NEW magazine

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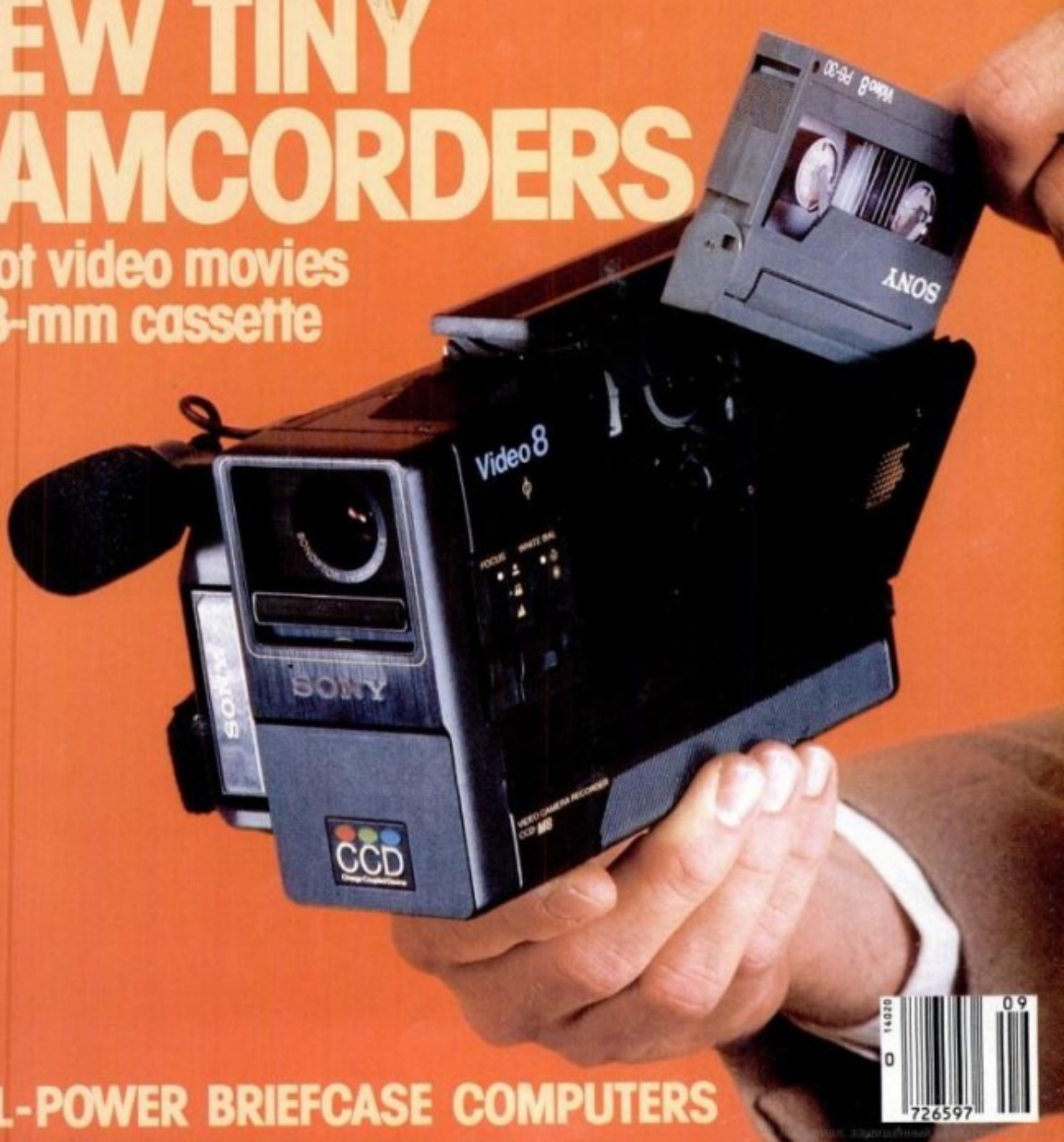
COMING: NEW WAVE OF UNDER-$5,000 CARS

NEW TINY CAMCORDERS

shoot video movies on 8-mm cassette



FULL-POWER BRIEFCASE COMPUTERS

The WHAT'S NEW magazine
Popular Science

What's News

I remember when a television camera weighed 200 pounds and rolled around on a heavy tripod. And a videotape recorder was bigger than a refrigerator and used huge reels of two-inch-wide tape. We've seen both cameras and recorders come down in size, but who would have dreamed even a few years ago that both camera and recorder would be jammed into something weighing two pounds and no bigger than a thick paperback book? To achieve this incredible size reduction Sony engineers used the new standard videotape, only eight millimeters wide. To create the image, they used a charge-coupled device—more compact than the old video tubes. And they left off some of the goodies provided by larger cameras—extras such as electronic viewfinders (this one is optical), automatic focus, and a zoom lens. In addition, the unit cannot play back tapes; to do that you need a separate playback unit.

But that's available, too, as are all manner of other video paraphernalia. They're all described in Susan Renner-Smith's article. The cover photo was taken by Greg Sharko.

Thinness champ. We thought the Sony compact-disc player that appeared on our May cover was small. But now a new unit (above) developed by Technics is even smaller. And it's rugged. At a recent demonstration I shook the unit violently while it was playing. I could hear absolutely no wavering of tone, jumping of tracks, or any other effect. It's versatile: You can program up to 15 tracks to play in any order; a skip key makes it jump over one or more tracks; a repeat function replays an entire disc in any order. The suggested retail price is $300, but if past experience is any guide, that price will soon be heavily discounted.

New-technology aero engines

• Avco Lycoming, one of the country's leading manufacturers of engines for light planes, and John Deere Technologies have announced a venture to develop a stratified-charge rotary aircraft engine in the 350–400-hp class (see "What's New," this issue). John Deere—long known as one of the country's largest farm-machinery manufacturers—got into the rotary-engine business last year when it bought out the division of Curtiss-Wright Corp. that had been working on Wankel-engine development for many years. Flight testing of the new engine is scheduled to begin in 1987.

• Porsche, which one observer described as a company that builds a car that could probably qualify as a low-flying aircraft, is indeed going into the airplane business. Porsche says it's going to adapt its air-cooled, 210-hp, six-cylinder PFM 3200 engine for use in single-engine light planes. Porsche says the new engine will use less fuel and will be easier to control. Instead of the conventional throttle, fuel-mixture, and propeller-pitch controls, it will have a single control combining them all. And in perhaps its most dramatic departure from convention, the engine will have a muffler and use a slower-turning prop, so it should be dramatically quieter than today's aviation engines.

Plastic plane goes military

The Avtek 400 ["Hot New Shapes," PS, June '84; "What's News," Feb.] was designed and built almost totally of plastic. The main reason: to be light enough to haul executives across the country while not using much fuel. That it apparently will do. But that same advantage, it now seems, is attracting military planners. They point out that its fuel economy and range would also make it an excellent antisubmarine patrol craft. At the same time, its practically all-plastic construction makes it hard to spot by radar. Pentagon officials, consequently, are talking to Avtek, and Valmet Corp., a Finnish military-plane builder, has bought into the company. Now, says Avtek president Robert Adickes, it seems that the principal market for the plane will be the military.

Editor-in-Chief

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New tiny camcorders

shoot video movies on 8-mm cassettes

By SUSAN RENNER-SMITH
Drawings by Nina Wallace

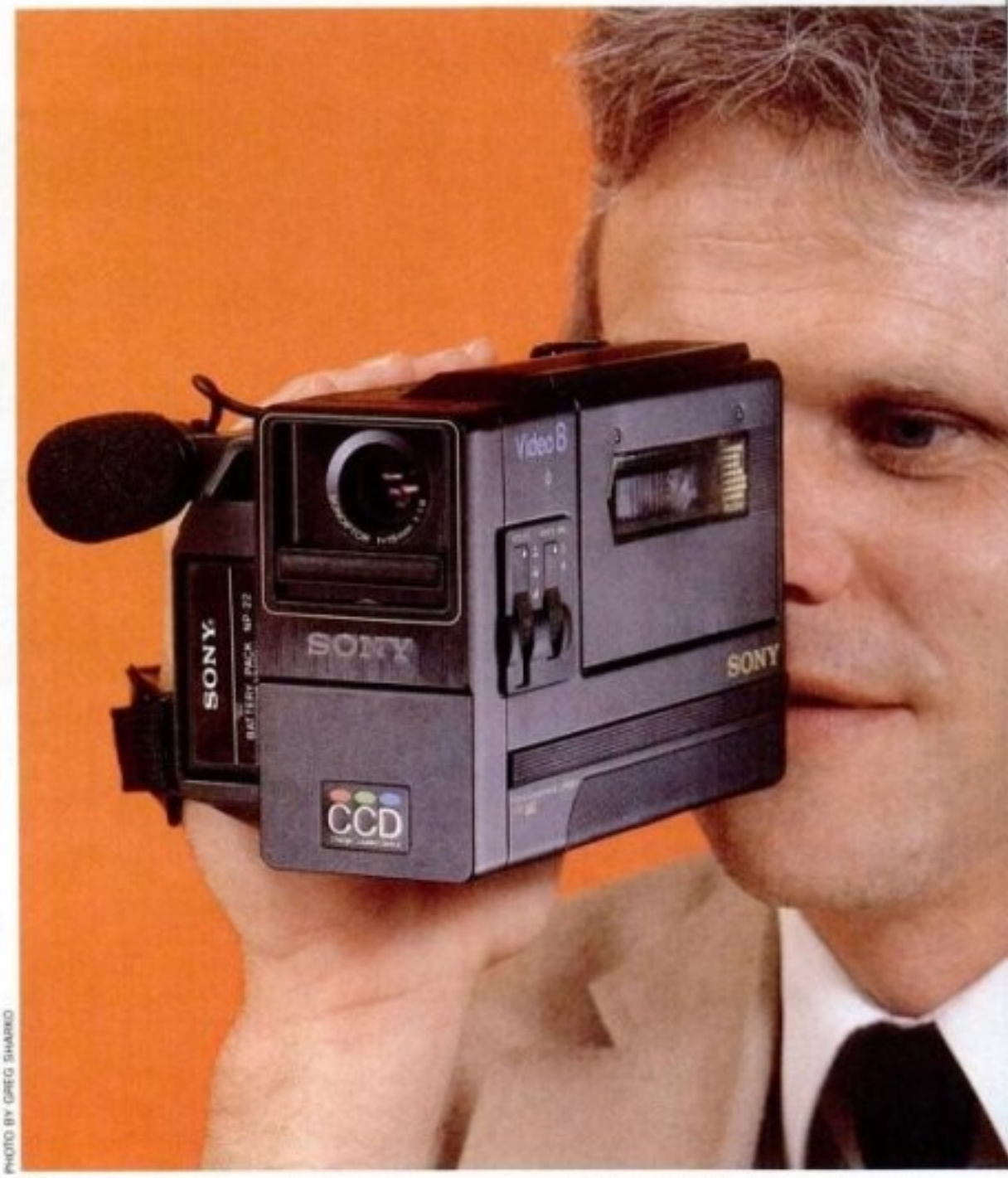

PHOTO BY GREG SHARKO

About the size of a Brownie box camera, the Sony Mini-8 camcorder (above) takes full-color-and-sound video movies. The unit even splits into two pocket-sized pieces. For video recording, read-write heads encode the video signal as the tape moves around the spinning drum (right, top). The FM audio is laid down simultaneously (right, middle), but a segment is left free for later PCM stereo dubbing. The tape can also be divided into six segments (right, bottom), each recording up to 4 hrs. of two-channel digital sound. To squeeze

"What's going on?" said POPULAR SCIENCE photographer Greg Sharko as the rich sound of Tchaikovsky suddenly filled the room.

We'd come to Sony Corp. of America's headquarters in Park Ridge, N.J., to photograph the tiniest video camcorder (camera-recorder) yet—Sony's new two-pound Mini-8. We'd used the paperback-size camera, which takes a compact 8-mm video cassette, and had tried out the CCD-V8 ["What's New in Electronics," PS, Aug.]—a larger camcorder with more features. We'd played back our tapes on Sony's new 8-mm VCR, and had been impressed by their clarity and color fidelity. All this we'd expected.

But Sharko hadn't known that Sony's 8-mm VCR doubles as a digital-audio tape deck. And I hadn't known that 8-mm audio could sound this good.

Just when everybody thought that the home-video wars had been decided in favor of VHS, which now accounts for 80 percent of all VCRs sold, here comes 8-mm video with technological advances that can't be ignored. Kodak introduced the first 8-mm camcorder last year [PS, May '84]; General Electric and Polaroid followed with similar units [PS, March]. But at the Summer Consumer Electronics Show in June, five more companies—Canon, Fuji, Pioneer, Sanyo, and Sony—showed improved 8-mm camcorders; three, including Kodak, introduced 8-mm home recorders with digital-sound capability. I'll describe these newest units in detail later.

Why the push to 8-mm? One reason is obvious: Most 8-mm companies also manufacture Beta-format VCRs or still-photography equipment, and they want to be part of the video boom.

But advanced technology has its own momentum, and 8-mm is moving rapidly. "The possibilities are very broad in scope—almost anything can happen," says John Osterhout, 8-mm program director at Kodak.

An international standard

The irony is that 8-mm developed as a way to avoid competing formats. When manufacturers first started developing miniature video recorders [PS, Nov. '80], widely different formats emerged. So in 1982 an international group of 127 manufacturers convened the 8-mm Video Conference.

The result? "The cassette is standard, and so is the way the signal is recorded," said Tom Sugiyama, manager of corporate communications for Sony. He handed me what looked like an audio tape. "The mechanics—number of heads, tape path around the drum—can be done in various ways," he added.

The small video cassette is the most obvious difference between ½-inch video and the new 8-mm version. To shrink the cassette to its 95-by-62.5-by-15-mm (3.7-by-2.5-by-0.6-inch) di-

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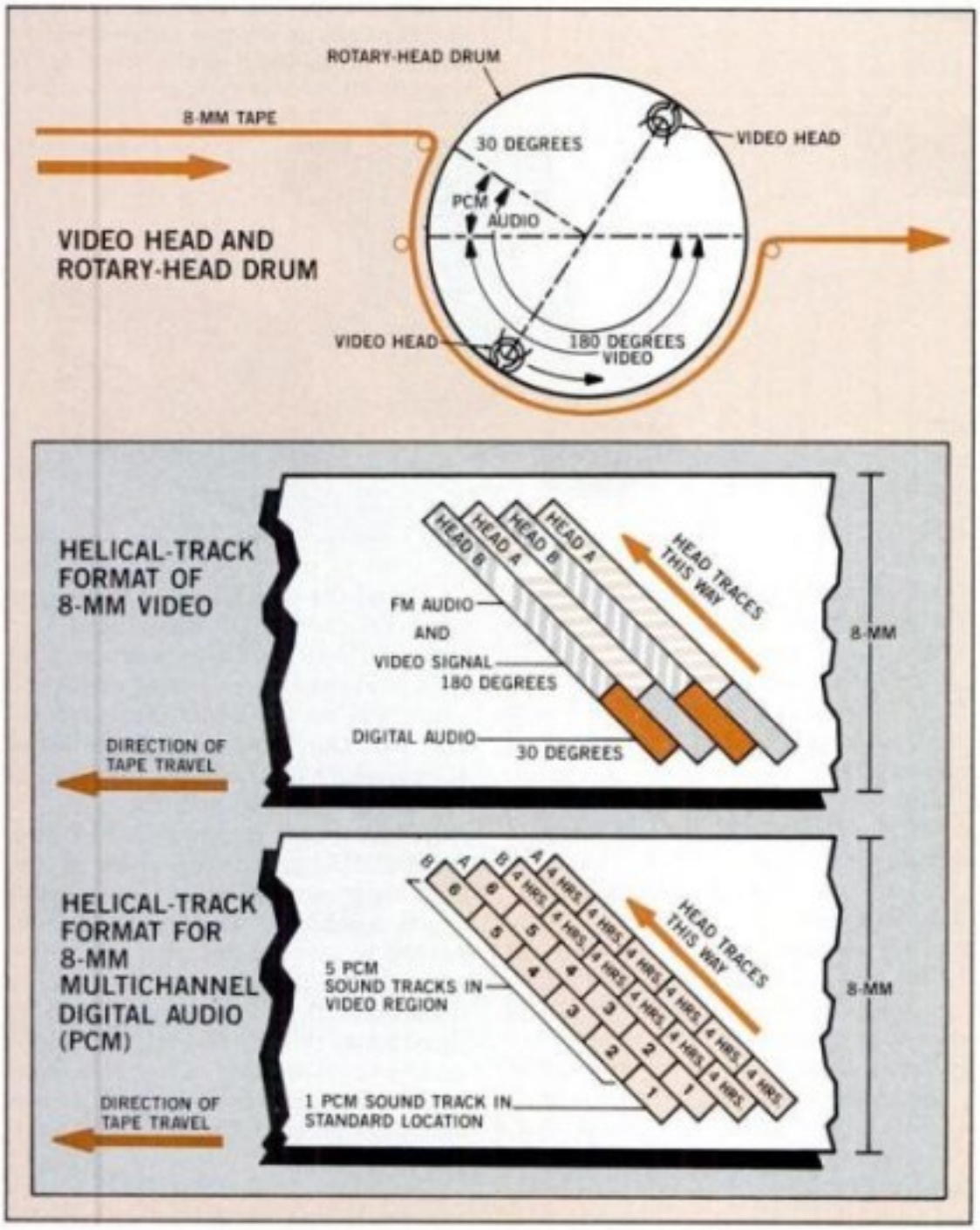
A triumph of video engineering, Sony's ultra-compact Mini-8 camcorder weighs barely two pounds. It's one of a new breed of small, truly portable camera-recorders that use 8-mm videotape to produce pictures approaching the quality of full-size video recorders. New 8-mm VCR decks from Kodak, Sanyo, and Pioneer also record audio digitally, for crisp high-fidelity sound on tapes that play as long as 24 hours.



the digital sound track onto the tape, an eight-bit "word"—a string of off-on signals containing signal information—was chosen instead of the 16-bit word used for compact discs. This gives a frequency range of 50 Hz to 15 kHz, so 8-mm recorders cover less of the audio spectrum than do compact discs, which have a range of 20 Hz to 20 KHz. But the dynamic range—the ratio between the loudest and softest sounds the recorder can re-produce without distortion—is close: 90 dB for the compact disc, 88 dB for 8-mm.

mensions, the conference chose to use pure-metal tapes, 13 microns (millionths of a meter) thick. These have finer, more densely packed metal particles and can record more signal than can the oxide tapes used in ½-inch cassettes. More of the tape can be wound on a reel, so the first 8-mm cassettes could hold as much video as a 90-minute ½-inch tape.

I inspected the cassette in my hand—and was surprised. I'd expected to see a gleaming ribbon of advanced metal-evaporated tape, the kind shown with the first prototype 8-mm camcorder. Instead, I saw ordinary-looking plain-brown stuff. It's metal-particle tape—an alternative type of tape that also conforms to the standard, according to Mac Inoue, Sony's product manager for consumer products.

Why? "To make this metal-particle tape, we just 'paint' the magnetic material onto the polyester base," Inoue said. "It's very hard to evaporate metal onto tape—manufacturers haven't perfected the process."

Recording the signal

The standard 8-mm recorder writes (and reads) video on tape via the helical-scan method—basically the same way ½-inch recorders do. Read-write heads set in the sides of a fast-spinning metal drum rotate at a slight angle to the direction of tape travel, swiping the tape diagonally to fit more information onto it (see drawing).

"But the 8-mm drum is smaller—40 mm instead of 74.5 mm for Beta," Inoue explained, pointing to a miniature metal cylinder inside an 8-mm recorder with its case removed. The 8-mm tape passes by this drum at a tape speed of 14.32 mm per second (compared with Beta II's 20 mm/s). But the head-to-tape speed is 3.8 meters per second (Beta's is 6.99).

A key difference between the new 8-mm standard and standard ½-inch video is the way the audio signal is handled. Most VCRs use a non-spinning read-write head similar to the one used in a standard audio-cassette recorder. Beta hi-fi recorders [PS, Nov. '83] use heads on the spinning drum to write a higher-fidelity audio signal on the tape; so do 8-mm recorders. These recorders leave space on the tape for dubbing in another sound track—a digital-stereo pulse-code-modulated (PCM) audio (see drawing).

Despite these audio possibilities, the first 8-mm units had shortcomings. The compact camcorders produced comparatively short-playing 90-minute tapes with a video quality that some thought mediocre. To play back the tapes on a TV screen you needed a bulky converter, and to record from the TV, you plugged in a minimum-function tuner-timer. These first-generation VCRs had no digital-audio capability, and thus no stereo sound.

"Shortly after the standard was developed, de facto amendments were added to improve it," Kodak's Oster-

Continued

PHOTO BY GREG SHARKO

1

2

PHOTO BY GREG SHARKO

3

The newest 8-mm units include prototype Canon camcorder (1) and Fuji camcorder (2) now sold in Japan. Sony's 5-lb. CCD-V8 dwarfs the 2-lb. Mini-8 camcorder (3), which uses the 2-lb. player-recorder (4) for tape playback. Kodak's home video deck (5) has a stereo tuner-timer with on-screen programming of eight events over three weeks. The 2-lb. modular recorder detaches from the tuner for portable playback. Sony's home video deck (6) has 4-hr. long-play mode; tuner-timer records six events over three weeks.

hout told me. A thinner, 10-micron tape was developed that could record two hours of video. Next, manufacturers devised a long-playing mode that stretched playing time to four hours. At the same time, manufacturers worked within the standard's limits to refine performance.

"People usually think that the same standard means the same quality," said Masa Namiki, general manager of communications for Sony in Japan. "This is wrong. We were determined not to introduce an 8-mm camcorder until it was equal to Beta quality."

Sony sent four 8-mm prototypes back to the lab to improve the video, Namiki told me. Finally, Sony produced the five-pound CCD-V8—and, a few months later, the miniature CCD-M8U, dubbed the Mini-8, shown on the cover. Each produces video quality identical to that of full-size Beta II systems, according to the company.

Shrinking a video camera

But it's the Mini-8 that shows the potential of second-generation 8-mm video. Somehow Sony has compressed the complex circuitry of a video camera into a case the size of a paperback book—and has made shooting videotapes as simple as taking a snapshot.

How? Inoue held up a four-inch-long cylinder I recognized as the electron tube used by video cameras to convert light to a video signal. "This tube used to determine the size of video cameras," he said. "But now we use these." He handed me a shimmering silicon wafer, about three inches across, with 50 tiny rectangles etched on its surface. "Each one is a CCD," Inoue said, pointing to the rainbow-hued rectangles.

Dubbed "the chip that sees" [PS cover story, Jan. '82], a charge-coupled device, or CCD, is a large-scale integrated circuit with thousands of tiny photosensors, or picture elements, etched on one face. These register light intensity, converting it into "packets" of electrons and storing these charges until the chip's circuitry converts them to an electronic signal.

Besides being smaller, the solid-state CCD is more reliable and durable than an electron tube. But resolution has been a problem.

"Our CCD is larger," Inoue said, referring to the chip used in first-generation camcorders. "We have developed a CCD with 250,000 sensing elements; earlier CCDs had about 197,000."

Why did it take so long to develop a high-resolution CCD? "This CCD is 8.8 mm by 6.6 mm [0.35 by 0.26 inch]," Inoue pointed out. "It's very hard to etch 250,000 elements on such a tiny chip."

Another difference: Unlike most other VCR makers, which use ferrite heads, Sony uses sputtered sendust, an advanced alloy. "It's very expensive, but it has a high signal sensitivity," said Inoue.

Sony first used the high-resolution CCD and the new heads in the larger CCD-V8 camcorder introduced last spring. There are three heads in that unit, and the tape is loaded about the same way as in ½-inch Beta recorders. But the Mini-8 has a different tape-loading mechanism, which Sony is not yet ready to describe.

"All I can tell you now," said Inoue, "is that this small camcorder is mechanically very different from other 8-mm machines. And the head technology is very important."

Sony has also shrunk the packing density of the electronic circuits to three times that of the earlier CCD-V8 camcorder. "We used newly developed high-density integrated circuits especially designed for the purpose," Sugiyama told me.

The Mini-8 is also small because it's simple: It has an optical viewfinder instead of an electronic one, and a fixed lens with three-zone focusing instead of a power zoom; and it records only.

It certainly is simple to use. I've never used a video camera, but I felt comfortable with the Mini-8. Slide the lens cover open, and you've automatically set the focus on the middle zone —three feet to infinity. Slide the white-balance (color-correction) button to "indoor" or "outdoor," and sight through the bright optical viewfinder. Seconds after picking up the little camcorder, I was shooting my first videotapes.

The Mini-8 has an 80-minute battery. For playing back tapes, there's a

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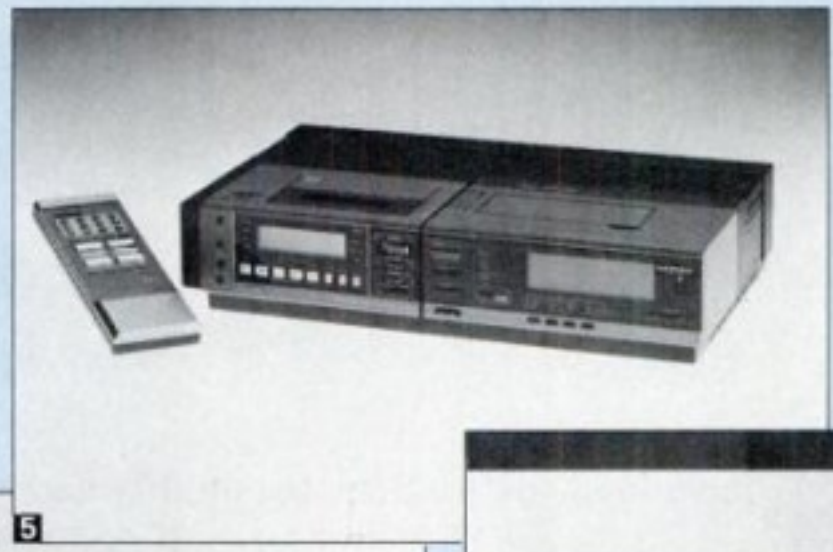

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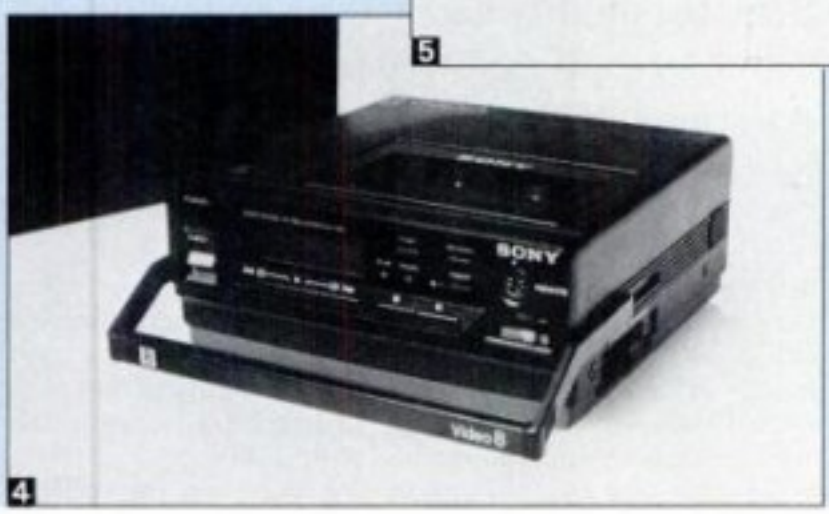

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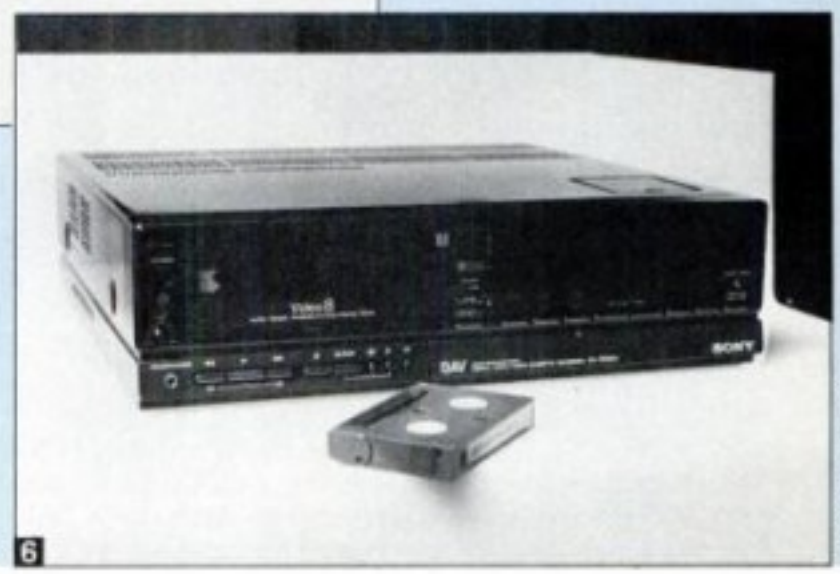

6

PHOTO BY GREG SHARKO

PHOTO BY GREG SHARKO

separate two-pound player-recorder (included in the $1,800 list price) that hooks into any TV.

"The Mini-8 is designed to be used like a snapshot camera," Namiki told me. "The player is for you to take to your mother's house to show her films of your son's graduation."

If you want more features, there's the CCD-V8. "This one is an Instamatic," Sugiyama said, pointing to the Mini-8. "This is a Nikon," he added as he handed me the five-pound CCD-V8. The CCD-V8 has an electronic viewfinder, a manually focused power-zoom lens, and full playback capabilities for editing as you shoot. The CCD-V8 records up to 60 minutes on a charge and lists for about $1,700. I used Sony's new tape deck for viewing the tapes, but there's also a plug-in adapter that hooks the CCD-V8 to any TV.

I compared the tapes made with both camcorders, and found the Mini-8 tapes to be just slightly less sharp and the colors slightly warmer than the amazing, almost-studio-quality scenes shot with the CCD-V8.

The new camcorders announced by Fuji and Sanyo are essentially clones of the CCD-V8. But Sanyo's version, when released, will have autofocus, according to Sanyo's Michael Ollins—as does Canon's new VM-E1.

Canon is the only company besides Sony to make its own camcorder (Matsushita makes Kodak's and GE's; Toshiba makes Polaroid's.) About the same size and weight as the CCD-V8, Canon's camcorder has a ½-inch high-band Saticon picture tube and a precision, semi-through-the-lens autofocus zoom with a close-up macro mode.

I found the VM-E1 easy to use, despite sophisticated features such as power-saving automatic shut-off. But the unit I tried was a pre-production prototype, and its video quality was not up to final specs, according to Canon spokesman Mike Matzkin. The VM-E1 has a 90-minute battery pack and lists for $1,600.

And now—the music

"A working group of about a dozen companies got together and asked: 'Why don't we develop multichannel digital audio?'" said Kodak's Osterhout. The result: The newest 8-mm VCRs record either video or digital audio (see drawing) on one small cassette.

Kodak, Sony, and Pioneer are aiming their new 8-mm VCRs at music lovers. These are full-feature VCRs (see caption), but they are still limited to four hours of video on a cassette instead of the eight hours you can get with some VHS decks.

Push a button, however, and you convert the video recorder to a high-fidelity, stereo-audio player-recorder. All three decks have standard dual-channel audio for audio input from any source, including compact-disc players.

The 8-mm tape can hold six channels of digital sound (see drawing for details). If you use a two-hour tape, you get two hours per channel. And the Sony deck has a long-play audio mode that lets you record and play four hours per channel. That's 24 hours of nonstop sound, if you want, or you can hop from channel to channel as your mood changes.

Eight-mm sound is almost as good as a compact disc's, makers say. "The high dynamic range, combined with the high frequency response, results in quality that the average listener would not be able to distinguish from that of a compact disc," said Osterhout. "It's a noise-free sound; there's no hiss during quiet periods."

And Osterhout expects prerecorded 8-mm audio tapes to become available. "There may not be many prerecorded 12-hour tapes," he pointed out, "unless you put all of Beethoven's symphonies on one. But if you just use all six tracks on a 30-minute tape, you get three hours of audio, compared with 30 minutes per LP side and 60 minutes per compact disc."

The Sony EV-S700U home deck lists for $1,500; Kodak says that its MVS-5380 deck's cost will be competitive with the price of high-end VCRs.

Will 8-mm VCRs and camcorders remain a curiosity—or will they become a permanent part of the home electronics scene? If 8-mm finds acceptance for home movies and digital-audio recording, makers hope, the format will coexist with—and maybe one day replace—standard ½-inch videotape. PS

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New-generation full-power

briefcase computers

Today's portable computers are masterpieces of sophisticated design. But they push technology to the limits, and certain compromises in size, weight, cost, and performance have been made. Now engineers are working on improved displays, smaller disk drives, low-power-drain circuitry, and innovative component layout for desk-top computer power and operating convenience in an even smaller package.

By STEVEN ASHLEY
Color photo by Greg Sharko

The first raindrops spattered the pavement as I dashed into the shelter of the subway entrance. Halfway down into the stairwell's growing gloom, my relief at staying dry turned to anxiety over the $2,000 portable computer slung across my shoulder. Unnoticed, I slipped the sleek 11-pound machine into my leather briefcase and calmly made for the incoming train.

Not too long ago, the mere thought of lugging a personal computer around the New York City subway system would have been unthinkable. So much progress has been made in cramming ever-more computing power into ever-smaller packages, however, that it's bound to alter the way we view and use these versatile devices.

To find out where this rapidly advancing field is now and where it's headed, I recently collected a group of briefcase-sized computers—those you see in the photographs that accompany this article. I found that despite their diminutive size, they approach and in some ways equal the power of their full-size desk-top cousins. I also discovered some glaring shortcomings. Then I traveled across the country to talk with the engineers now designing the next generation of portable microcomputers. I saw where they're aiming their efforts, some of the barriers to attaining their goals, and how these barriers will be overcome.

PC's progress

The most striking fact about the personal-computer field is the incredible progress that's been made in a short time. An article in a recent issue of *Scientific American* put it this way: "If the aircraft industry had evolved as spectacularly as the computer industry over the past 25 years, a Boeing 767 would cost $500 today, and it would circle the globe in 20 minutes on five gallons of fuel. Such performance would represent a rough analogue of the reduction in cost, the increase in speed of operation and the decrease in energy consumption of computers."

That passage didn't directly compare size and weight—the main distinguishing characteristics of the new micros—but the same comparisons prevail. In fact, each of these small machines has more computing power than the huge, room-filling mainframe computers of the early 1960s.

So what can such machines do for you? The basic answer: everything desk-top machines can. They display a wide variety of capabilities and price tags, and even low-end models display astonishing capabilities. They do acceptable on-the-go word processing, run spread-sheet programs, make graphs, and communicate with other machines over modems.

Yet the extreme emphasis on small size and light weight has made certain engineering compromises necessary. An example: I, as a writer, do word processing of lengthy documents. That means a lot of machine time. But the displays of some machines can become tiring with time. Other machines with easier-to-read displays are heavier and more power hungry, so they are almost limited to use with AC power. They're also more expensive. So for a better display—fine for long-term use—you give up lightness and the ability to operate for extended periods on battery power. And you pay more.

I also discovered, after carrying several of the briefcase-sized machines home, that there's a big difference in convenience between 10 and 12 pounds. Lighter is definitely better. I found, too, that two pounds can make a big difference in capability. And this time, *heavier* is better. Thus the question becomes: Just how much functionality and convenience are you willing to forego for how much portability? And how much are you willing to pay?

The display is the key

Even as you contemplate that, engineers are working to make compromise unnecessary. And there is full agreement on where the greatest challenge—and opportunity—lies. Says Howard Fullmer, director of advanced product development at Morrow Designs: "Once somebody develops a low-power flat-panel display that's as easy to read as that thing over there," he jerks a thumb over his shoulder at a bulky, late-model office terminal behind him, "portable PCs will be on their way."

"The biggest single technology issue in briefcase computers is the display," agrees Johnny M. Barrett, program manager for Texas Instruments. Early in 1981, he and his colleagues began their search for a suitable replacement for the voluminous, power-munching (15 to 20 watts) cathode-ray tube, or CRT. "There weren't more than two display vendors who would talk with us," he said. "What we were looking for didn't really exist."

Current technology indicates how far the industry has come. Three basic flat-panel-display technologies are used in today's briefcase computers: electroluminescent (EL) and gas-plasma (GP) panels, both of which are active, or light-emitting, devices, and the familiar liquid-crystal display (LCD), a passive, or light-reflecting, system.

All are similar in basic layout, with an electrically reactive material between a pair of electrode matrices sealed within a glass envelope. Particular pixels, or image dots, are activated by an array of row-and-column electrodes that intersect in front and behind, allowing few driving circuits to address and turn on and off many pixels.

The GP systems, such as the Ericsson Portable PC and the GridCase 3, ionize a neon or neon-argon gas mixture to produce illuminated dot images. The panels are easier to read than LCDs. Unfortunately, the costly devices require heavy glass to contain the gas and very high voltages to light up, consuming power at a high rate.

In EL panels, found in the Grid Compass line, for example, the electrically reactive material is a luminescent chemical such as a zinc sulfide-manganese mixture. In many ways, EL panels are more legible than CRTs found in larger computers, but

Continued

Sampling of full-function, briefcase-sized personal computers now on the market (clockwise from left): Texas Instruments Pro-Lite, Hewlett-Packard Portable (center), Ericsson Portable PC, Kaypro 2000, and Tandy 200.

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they're not cheap. ELs weigh less and consume less power than GP displays (15 to 20 watts compared with 30 watts) but are heavier and use more power than LCDs.

Most of today's portable microcomputers employ the familiar LCD technology. LCDs create an image when a small electric field is induced across the pixel's electrodes. This forces elongated liquid-crystal molecules to line up side by side. The molecular alignment prevents incoming polarized light (transmitted by a front-plate polarizer) from being reflected by a backplate polarizer/mirror back out to the eye. Thus the eye sees a black dot. When the tiny applied current is removed, the dot disappears.

LCDs are fine for battery-operated machines because an entire screen draws less than one watt. Because they do not emit light, however, they are difficult to read in low light. Some machines, including the Sharp PC 7000, the Morrow Pivot II, and the Zenith Z-171 Personal Portable, have illuminated their LCD screens with low-power EL backlights, making them easier to read in low light.

LCDs are also hard to read unless you view the screen at precisely the right angle. Move your head up or down a little and you may lose the image. I had this demonstrated dramatically—and frustratingly—recently when I tried to operate an LCD machine for a fellow passenger on a train. The light was not very good, the positioning was awkward, and she never was able to read the display.

But better LCD displays are on the way. Panelvision Corp. of Pittsburgh, along with some Japanese companies, is working on a new approach. According to T. Peter Brody, director of technology at Panelvision, tiny thin-film transistors mounted on glass plates regulate the charge on each LCD pixel, thus eliminating "the limitations of 'traditional' LCD designs." He explains: "As you increase the number of rows, you have more and more difficulty picking out each element, and you get cross talk between them. In other words, you have to hit the row with a hard enough charge to activate the LCD elements, but not so hard that the adjoining pixels come on." In the active-matrix approach, the regulation of the charge on each pixel allows precise addressing, so cross talk is avoided. This permits manufacturers to pack the pixels closer together into higher-resolution displays. The technology depends on the ability to produce large thin-film semiconductors inexpensively. Large manufacturing volumes will bring the price down, Brody predicts.

Data General/One's full-size LCD screen (top) is typical of the briefcase portables. The new 3.5-in. floppy-microdisk format is standard on the Kaypro 2000 (above left). Grid Systems' user-installable ROM packs allow the user to change software by merely popping in a cartridge (above right).

Many optical techniques have been tried to improve today's LCDs. Various anti-glare coatings are applied to the glass faceplates to reduce image-fuzzing reflections, but this also reduces the available light for reading. And dyes have been added to change the color of the LCD's silvery background. But looking at such screens, I couldn't see much difference.

Nevertheless, there is progress. In the future, say experts, look for new high-contrast liquid-crystal materials that can be seen from an angle, high-resolution color LCD displays, arrays of light-emitting-diode (LED) chips, and low-power "folded" and "flattened" CRT designs, all of which are still in their infancy.

Power cutters

While work goes on in display development, other researchers are working to make even-more-compact, cheaper, less-power-hungry electronics. I saw one striking result of this quest at the Grid factory in Mountain View, Calif., when David Paulsen, director of engineering, showed me a disassembled GridCase machine fairly bursting at the seams with cunningly placed electronics. As I wondered how the technician there was going to stuff all those boards and wires into that minuscule space, Paulsen compared the custom gate arrays (large functional blocks of logic that can replace whole sets of standard chips) and surface-mount circuit boards (with chips fixed to both sides to double the chip density) with the equivalent IBM PC circuitry. The new technology was markedly smaller. "These were the biggest factors in our getting a PC into a box this size," Paulsen says.

Size isn't the whole game with electronics. Lowering power drain is important, too. To advance that goal, most machines now use CMOS (complementary metal-oxide semiconductor) chips. According to Dick Pashley, director of technology development at Intel Corp., "CMOS chips do the same job as conventional bipolar, or NMOS [n-channel metal-oxide semiconductor], chips but in a different way." The NMOS chip constantly conducts current, an obvious disadvantage in a battery-powered device. "With CMOS, you don't burn any power except when

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PS sampling of briefcase-sized computers

Manufacturer	Model	Price ($)	Size (in.)	Weight (lbs.)	Display	Keyboard	Power	RAM[1] (K)	Storage	Op. Sys.[2]	Interface: Ser.[3]	Par.[4]	Incl. software & peripherals: WP[5]	SS[6]	Gr.[7]	Sch.[8]	DB[9]	User[10]	Com.[11]	BASIC	Cl./cal.[12]	Mod.[13]	Calc.[14]	Sp.[15]
Data General 4400 Computer Dr. Westboro MA 01580	Data General/ One	2,995	13.7 × 11.7 × 2.8	9	LCD[16], 25 lines × 80 cols., 640 × 256 pixels	79 keys, 10 function keys	AC, recharg. battery (6-hr.)	256–512	3.5" 720K floppy, 3.5" floppy (opt.)[17]	MS-DOS, CP/M-86	•		•						•		•			•
Epson America 3415 Kashiwa St. Torrance CA 90505	PX-8 Geneva	995	8.5 × 11.5 × 1.75	4	LCD, 8 lines × 80 cols., 480 × 64 pixels	72 keys, 9 function keys	Recharg. battery (20-hr.)	64–184	Microcassette, 3.5" floppy (opt.), 64K RAM disk (opt.)	CP/M	•		•	•		•					•			•
Ericsson Info. Systems Box 2522 Greenwich CT 06836	Portable PC	2,995	15.4 × 12.2 × 4.5	16.7	GP[18] 25 lines × 80 cols., 640 × 400 pixels	84 keys, 10 function keys, numeric key pad	AC, recharg. battery (in dnr., 2-hr.)	256–512	5.25" 360K floppy, 512K RAM disk, (opt.)	MS-DOS, CP/M-86	•	•												
Grid Systems Corp. 2535 Garcia Ave. Mountain View CA 94043	1100 Compass (several versions)	4,250	11.5 × 15 × 2	10	EL[20] 25 lines × 80 cols., 320 × 240 pixels	57 keys	AC, battery (1-hr.)	256–512	384K bubble, 5.25" floppy (opt.) 10M[19] hard (opt.)	Prop. OS[21] (opt.), MS-DOS (opt.)	•	•	•	•	•		•	•			•			•
	GridCase 3	4,350	11.5 × 15 × 2.25	12	GP, 25 lines × 80 cols., 640 × 200 pixels	57 keys	AC, battery (1-hr.)	128–512	3.5" 720K floppy, 5.25" floppy (opt.), 10M hard (opt.)	Prop. OS (opt.), MS-DOS (opt.)	•	•	•	•	•		•	•			•			•
Hewlett-Packard Co. 1000 NE Circle Blvd. Corvallis OR 97330	Portable Plus	2,295	13 × 10 × 3	9	LCD, 25 lines × 80 cols., 480 × 200 pixels	75 keys, 8 function keys	AC, recharg. battery (16-hr.)	128–896	272K RAM disk, 3.5" floppy (opt.)	MS-DOS	•							•	•					
Kaypro Corp. 5133 Stevens Ave. Solana Beach, CA 92075	Kaypro 2000	1,995	13.3 × 11.5 × 2.6	11	LCD, 25 lines × 80 cols., 200 × 640 pixels	75 keys, 10 function keys	AC, recharg. battery (4-hr.)	256–768	3.5" 720K floppy, 360K RAM disk (opt.)	MS-DOS	•		•	•			•			•	•			
Morrow Designs 600 McCormick St. San Leandro CA 94577	Pivot II	2,995	13 × 6 × 9.5	13	LCD with EL lamp, 25 lines × 80 cols., 640 × 200 pixels	63 keys, 10 function keys, 4 icon keys	AC, recharg. battery (3.5-hr.)	256–640	5.25" 360K floppy, 5.25" floppy (opt.)	MS-DOS	•	•	•			•		•	•		•		•	
NEC Home Electronics 1401 Estes Ave. Elk Grove Village IL	PC-8401A Starlet	995	12 × 8.5 × 2.25	4.5	LCD, 16 lines × 80 cols., 480 × 128 pixels	68 keys, 5 function keys	AC, battery (8-hr.)	64–96	Two 3.25" floppies (opt.)	CP/M	•	•	•	•			•		•		•	•		
Osborne Computer 42680 Christy St. Fremont CA 94538	Osborne 3	2,195	13 × 5.5 × 9.5	9.5	LCD, 16 lines × 80 cols., 480 × 128 pixels	63 keys, 5 function keys, 4 icon keys	AC, recharg. battery (4–5-hr.)	128–512	5.25" 360K floppy, 5.25" floppy (opt.), cassette (opt.)	MS-DOS	•	•				•			•		•	•		
Quadram Corp. 4355 Int'l Blvd. Norcross GA 30093	DataVue 25	2,195	13 × 6 × 10.5	12.1	LCD, 25 lines × 80 or 40 cols., 640 × 200 pixels	83 keys, 10 function keys, numeric key pad	AC, recharg. battery (6-hr.)	128–1M	5.25" 360K floppy, 512K RAM disk (opt.)	MS-DOS	•	•									•			
Sharp Electronics 10 Sharp Plaza Paramus NJ 07652	PC 7000	under 2,000	16.1 × 6.3 × 8.1	16	LCD with EL lamp, 25 lines × 80 cols., 640 × 200 pixels	84 keys, 10 function keys, numeric key pad	AC, recharg. battery (time n.a.)	256–640	Two 5.25" 360K floppies, hard (opt.)	MS-DOS	•	•									•			
Sord Computer 645 Fifth Ave. New York NY 10022	IS-11C	1,395	11.8 × 8.4 × 3.3	6.4	LCD, 25 lines × 80 cols., 640 × 200 pixels	70 keys, 6 function keys	AC, recharg. battery (3.5-hr.)	80	256K micro-cassette, 64K RAM disk (opt.)	Prop. OS	•	•	•							•		•	•	
Spectravideo 3300 Seldon Ct. Fremont CA 94539	Bondwell 2	under 1,000	11.2 × 3.1 × 12.2	12	LCD, 25 lines × 80 cols., 640 × 200 pixels	69 keys, 8 function keys	AC, recharg. battery (8-hr.)	80	3.5" 360K floppy	CP/M	•	•	•	•		•								
Tandy Corp. 1500 One Tandy Ctr. Fort Worth TX 76102	Tandy 200	999	11.75 × 8.5 × 2.2	4.5	LCD, 16 lines × 40 cols., 240 × 128 pixels	56 keys, 8 function keys	AC, battery recharg. battery	24–72	5.25" 184K floppy (opt.), cassette (opt.)	Prop. OS	•	•	•	•		•		•	•		•	•	•	•
Teleram 2 Corporate Park Dr. White Plains NY 10604	Model 5000	2,495	13 × 9.75 × 4.3	10	LCD, 16 lines × 80 cols., (no pixel breakdown)	83 keys, 16 function keys, numeric key pad	AC, recharg. battery (5-hr.)	64	128–256K bubble, four 5.25" floppies (opt.)	CP/M	•		•					•						
Texas Instruments Box 809063 Dallas TX 75380	Pro-Lite	2,995	11.5 × 13 × 2.74	10.5	LCD, 25 lines × 80 cols., 640 × 200 pixels	79 keys, 12 function keys	AC, recharg. battery (8-hr.)	256–768	3.5" 720K floppy, 3.5" floppy (opt.)	MS-DOS		•												
Zenith Data Systems 3000 Milwaukee Ave. Glenview IL 60025	Z-171 Portable Personal	2,699	13 × 6.6 × 9.5	14.3	LCD with EL lamp, 25 lines × 80 cols., 640 × 200 pixels	63 keys, 10 function keys, 4 icon keys	AC, recharg. battery (3.5-hr.)	256–640	Two 5.25" 360K floppies	MS-DOS	•	•				•		•	•		•		•	

[1]RAM (K): random-access memory (kilobyte); [2]op. sys.: operating system; [3]Ser.: serial; [4]Par.: parallel; [5]WP: word processing; [6]SS: spread sheet; [7]Gr.: graphics; [8]Sch.: scheduling; [9]DB: data base; [10]User: user interface; [11]Com.: communications; [12]Cl./cal.: clock-calender; [13]Mod.: modem; [14]Calc.: calculator; [15]Sp.: speaker; [16]LCD: liquid-crystal display; [17]Opt.: optional; [18]GP: gas plasma; [19]M: megabyte; [20]EL: electroluminescent; [21]Prop. OS: proprietary operating system

you're switching on or off. This leads to one-tenth the power consumption compared with that of a PC with NMOS. Unfortunately, right now CMOS can cost anywhere from 20 to 100 percent more to build than NMOS."

Most of these portables make extensive use of CMOS chips, but there are cost limitations. "Take CMOS RAM [random-access memory] chips," says David Kay, vice president of product development and marketing at Kaypro Corp. "Even though it draws 10 percent more power, we used NMOS RAM in the Kaypro 2000 because RAM uses a relatively small fraction of the machine's entire power draw. CMOS just wasn't worth it there."

[Continued on page 114]

Sharp PC 7000 (above) and Morrow Pivot II (right) portable microcomputers both have full-size LCD screens that are backlighted by an electroluminescent lamp for improved low-light legibility. Both the 16-lb. Sharp and the 13-lb. Morrow machines come with industry-standard 5.25-in. floppy-disk drives.

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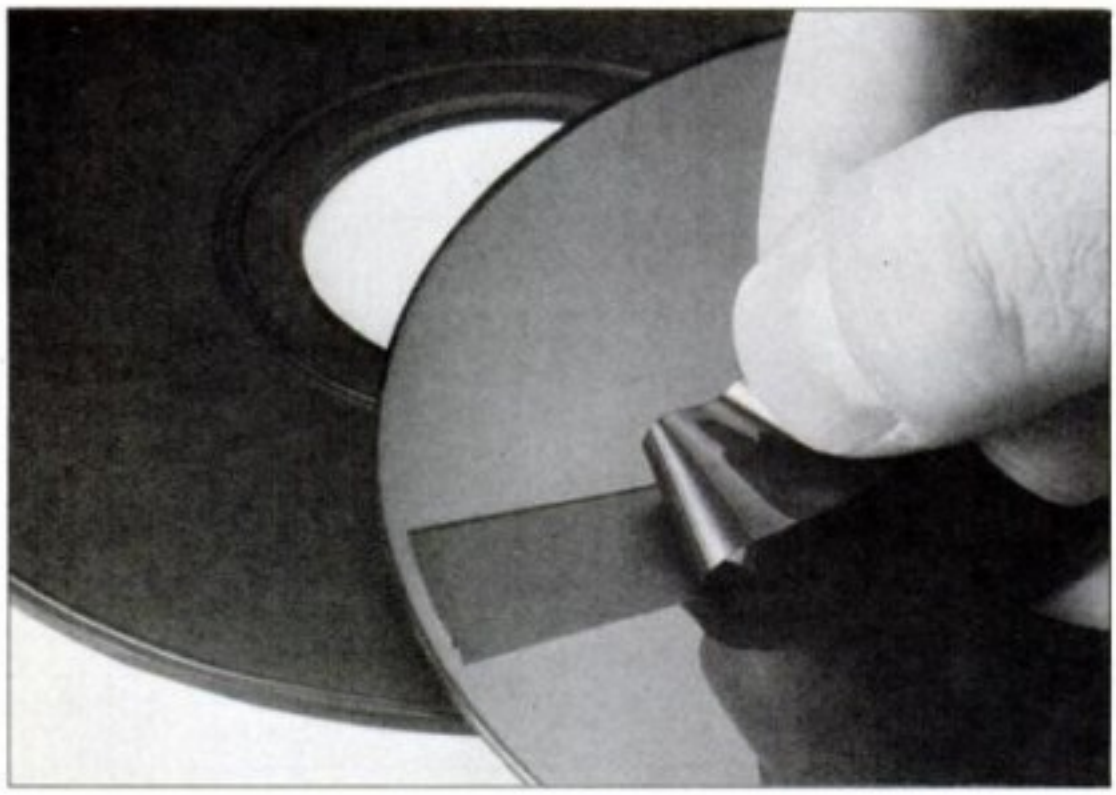
Stretching disk memories

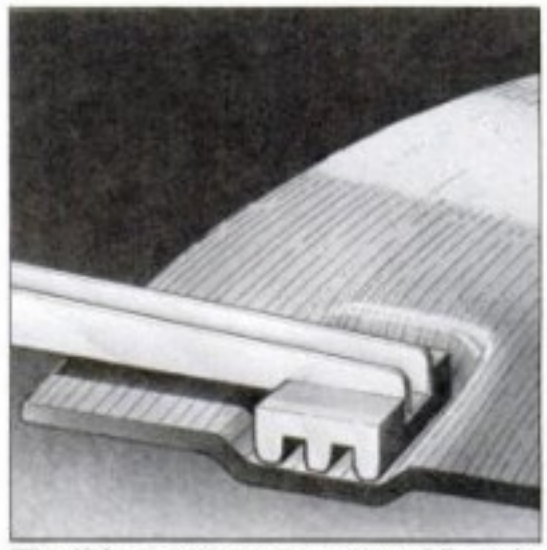
A flexible coating on a plastic base and "flying" read/write heads enable 3M's new stretched-surface disk to perform like a Winchester disk—without all the problems.



By JOHN FREE

New personal computers have smarter, faster microprocessors and colossal memories—a million characters (one megabyte, or 1M) of temporary data storage in some models. To store data permanently, floppy magnetic disks [PS, Dec. '83] have traditionally offered a rugged, highly portable storage medium. But today's powerful microcomputers handle jobs that require more disk capacity than floppies can deliver. So built into some computers, or added later, are hard-disk Winchester drives [PS, Oct. '82], which store and can rapidly retrieve tens of megabytes.

Now, 3M Co. (St. Paul, Minn.) is introducing a new type of computer disk that blends properties of both floppy and hard disks. The result, claims 3M, is a plastic hybrid that costs less and is easier to make than hard disks, is less susceptible to damage, yet matches the storage capacity of low-end Winchesters. Projected cost: $10 per disk. Several firms are testing drives for the new disk and are expected to market them shortly.



Flexible coating on new 3M disk, peeled away in photo, develops a small hollow beneath read/write head as disk spins rapidly. Air pulled around above disk's surface keeps head "flying."

3M's new stretched-surface recording disk has a rigid-plastic base instead of aluminum, which is used for hard disks. A film of magnetically coated plastic is stretched and bonded to the disk's raised edges. Says product-planning-and-development manager David Cross: "The resulting magnetic surface is extremely smooth and mirrorlike, with a ten-thousandth-of-an-inch gap underneath. Because of the gap, the surface is compliant."

This flexibility is important when the disk spins at 3,600 rpm with the read/write head "flying" just above its surface. Air pressure between the head and surface creates a small dimple (drawing).

"The stretched disk provides an extra margin of safety against a head crash," says Cross. "With the plated or sputtered surface of a Winchester, if the head touches a high spot or imperfection, you'll lose data, perhaps forever, and quite possibly ruin both the disk and head. The same risk occurs when the drive is jostled. But the compliancy of a stretched disk protects against that happening."

Stretching the plastic over the surface also minimizes a serious problem inherent in floppy disks: unstable track positions. Temperature changes warp a floppy's plastic and shift the location of its magnetic tracks. By comparison, says 3M, its stretched surface is 10 times more stable, shifting only 100 microinches. That means tracks can be recorded closer together to store more data. The capacity of 3M's initial 5¼-inch size is about 12M (both sides combined). Improved magnetic coatings should boost capacity to about 50M in a few years, says the company. Vertical recording, which aligns magnetic regions perpendicularly instead of horizontally, and optical recording techniques ["The Laser-Disc Revolution," PS, May] promise storage capacities of 100M or more.

To tap the growing computer market, 3M is moving quickly. Says Paul Husby, plant manager at 3M's Weatherford, Okla., division: "The product is moving directly from the laboratory into the manufacturing plant." PS

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